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Revamping Old Sewage Treatment Plants

Utilization of Old Units in Modernized Plants Frequently Desirable—Methods and Examples of Conversion of Septic Tanks, Imhoff Tanks, Sand Filters and Trickling Filters

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THE state of Iowa has approximately 213 cities and towns possessing sewage treatment plants. For preliminary treatment 121 have septic tanks, 89 Imhoff tanks and 3 separate sludge digestion. For secondary treatment 123 have intermittent sand filters, 54 trickling filters and 4 contact beds. Thirty-two have no secondary treatment.

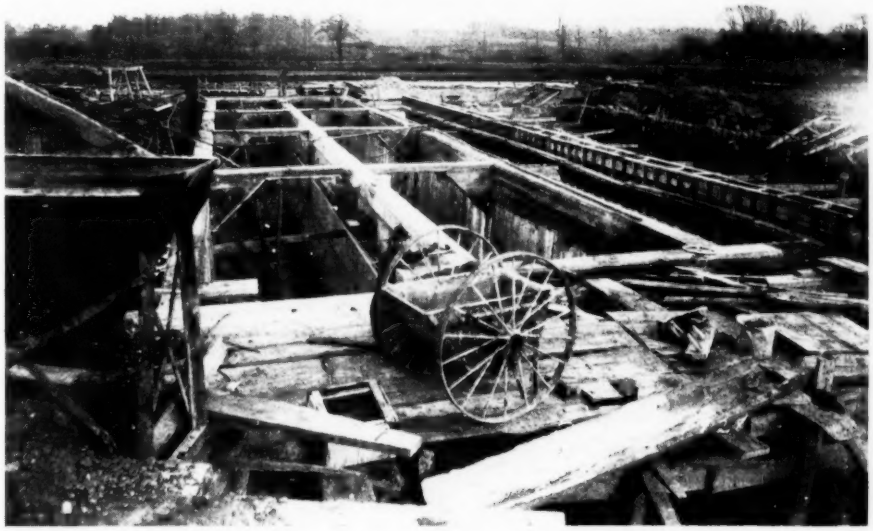
The plants in Iowa are quite typical of the plants situated in the various other states. These are the types that are most generally met with when revamping old plants, and will therefore be given the most consideration in this discussion.

Use of Old Units.—Many of the plants listed above are still giving good service, but as time goes on an increasing number are becoming undercapacitated or antiquated. When this condition occurs the plant operators and engineers are faced with the problem of finding the best way of utilizing a portion of their existing plants and still allowing the new design to embody modern methods of sewage treatment.

Septic tanks are no longer considered in the design of new plants, except occasionally for very small ones. While they served a much needed purpose at the time they were being built extensively, they failed to meet the expectations of their advocates, and have given way to Imhoff tanks and separate sludge digestion.

Sand filters are still applicable for small plants, or where a large amount of natural sand is available, but are usually too expensive to consider for larger ones. The rate of application is so low that they require a very large area, and consequently a considerable outlay of money; the same results being obtainable at much less expense. Therefore it is necessary to revamp these existing units to fit into the new scheme.

Present practice tends toward separate sludge digestion or Imhoff tanks for preliminary treatment, and trickling filters or activated sludge for secondary treatment. It is the purpose of this paper to discuss in a general way the possibilities and various schemes which have been used in modernizing old units to conform to present practice. Many city officials are willing to make the necessary improvements if they can see a way of saving a portion of the money already invested in sewage treatment, and still get a modern up-to-date plant.



Old Septic Tanks Being Revamped for Aeration Tanks at Salem, Ohio

Problems Met in Revamping.—It is not possible in this space to discuss fully all problems encountered in the revamping of existing plants. Each job presents a different problem and will require special study before recommendations can be made. However, there are certain general features which should always be considered. This paper will discuss these general features, including several examples of plants which have actually been revamped.

In studying a sewage treatment problem where a plant already exists, probably the most important consideration is to decide on whether to utilize the existing site, or select an entirely new site. This decision will depend upon several considerations, such as (1) the natural features of the site—elevations, accessibility, distance to final disposal, etc.; (2) whether the old site is so situated that it will interfere with the natural growth of the city; (3) if there is sufficient area for future expansion of the plant; (4) comparative cost involved in the utilization of the old versus the selection of an entirely new site.

Assuming that, after giving due consideration to these various points, the old site is selected, it is then necessary to decide what portion of the old plant can be salvaged. There are three important points to consider before making the decision: (1) the cost of revamping a particular unit as compared to that of the new unit, (2) the serviceability of the completed plant

Salem, Ohio, Sewage Plant Before Revamping

and (3) the local political situation. Comparative costs can usually be worked out with considerable accuracy, but the serviceability of the completed plant is an entirely different problem. Unfortunately, experience has shown that engineers have too often allowed the cost to be the predominating factor in the design of sewage treatment plants, forgetting that if they do not obtain the desired results they have failed in their object. The first consideration should always be to design the plant to give the required results; secondly, the design should be made as economical as practical.

The local political situation becomes of importance sometimes in making the decision as to whether portions of the old plant will be utilized. If a bond issue is to be put over, it can often be made to carry over considerable opposition if the public knows that a large part of the existing plant can be salvaged, although it might actually involve slightly greater expense.

Conversion of Septic Tanks.—The most usual types of old plants encountered are those using either the single or two-story septic tanks for preliminary treatment, followed by either intermittent sand filters or trickling filters.

Single-story septic tanks are usually of such proportions that they offer several possibilities for converting into other units. They might be converted into one or more of the following units: (1) aeration tanks for the activated sludge process with either air or mechanical aeration, (2) clarifiers, (3) sludge digestion tanks, (4) sludge storage tanks or (5) left as septic tanks and used to treat storm flow.

Considering the case where the new plant is to be of the activated sludge type, it then becomes of importance to determine the comparative sizes of the old tank and that required for the new aeration units. Single-story septic tanks have been designed for detentions varying from four to six hours. While septic tanks have been given a greater detention than will be required for the new aeration tanks, this is usually compensated for by the increase in design population over what it was when the septic tanks were built. To illustrate, suppose an old septic tank had been designed for a detention period of twelve hours to accommodate a population of 5,000. The new aeration tank is to have a detention period of six hours, but assume that the design population has increased to 10,000 during the lapse of time. It will then be seen that the old septic tank is just the right size. This is the actual situation for many cities. Septic tanks have the further advantage of being comparatively shallow, not requiring a great deal of work to convert them to the proper depth of channel.

Many of the old tanks can be converted easily into clarifiers and sludge tanks. They have often been converted into clarifiers by the installation of equipment, or used as plain settling tanks with hopper bottoms. At certain plants one end of the tank has been rebuilt to accommodate a clarifier and the remaining portion used either for sludge digestion or storage. Where small tanks are encountered they can often be most economically utilized for sludge storage.

Use of Old Imhoff Tanks.—Imhoff tanks have less possibilities than the single-story septic tanks, and are usually suitable only for either sludge digestion or storage, or sedimentation. An excellent scheme which has been used at many plants is to utilize old Imhoff tanks for sludge storage and conditioning after the sludge has been digested in another tank. By using this scheme the latest practice in sludge digestion can be followed at a very low cost. Investigators have found that most of the gas from sludge digestion is given off very soon after the sludge is placed in the tank, but in this country it is impractical to discharge it on to the drying beds for about five months during the cold weather; therefore, it is seen that a large portion of the sludge digestion tank must be used only for sludge storage. For new plants it is customary to construct the sludge digestion tank large enough to hold this five months' accumulation, but a considerable saving can be made in the size of the digester unit and also in the heat required to keep the sludge at the optimum digestion temperature if the excess can be drawn off and stored in a separate tank. Very little odor results from this practice as the gas is practically all given off before the sludge is drawn to the storage tank.

Old Sand Filters.—Old sand filters are always of greater area than required for sludge drying beds. The most common practice has been to abandon a portion of the sand beds, keeping enough only for sludge drying purposes. However, a few engineers have put these old beds to good service by using them for secondary treatment of the excess storm flow.

This practice results in considerable saving in the construction of the secondary treatment unit which can be designed to take care of the dry weather flow only.

Trickling Filters.—The last case that has to be considered is the utilizing of existing trickling filters. This problem is quite different from those which have been considered, because trickling filters are not obsolete and can usually be made to fit in the new design. If space is available the problem is simply one of adding additional filter beds. Often space is not available and it is necessary to resort to a type of treatment that does not require as much area. The engineers at Decatur, Ill., solved this problem in a unique manner when their plant became overloaded as a result of a large volume of industrial waste being discharged into the sewers. After preliminary sedimentation the effluent is given a short period of aeration and then resettled; this effluent is dosed on the trickling filters at a relatively high rate.

Examples of Revamped Plants.—These various schemes which have been pointed out are well illustrated by the following plants which have recently been revamped. Salem, Ohio, furnishes a typical example of an old septic tank, intermittent sand filter plant being revamped to the activated sludge type. The old plant was designed and built

in 1912, and consisted of essentially three septic tanks, each 20 ft. by 90 ft. 6 in., with an effective depth of approximately 7½ ft.; intermittent sand filters and a chlorination basin. The new plant is of the separate sludge digestion, activated sludge type, and consists of a mechanically-cleaned bar screen; two 35-ft. clarifiers for settling activated sludge; one 50-ft. diameter sludge digester, equipped with mechanism and gas collection and heating features; one 18 ft. 6 in. by 10 ft. 6 in. deep sludge storage and conditioning tank, and a portion of the old sand beds used for sludge lagooning. The design was made on a basis of 15,000 population with an average dry-weather flow of 1.5 m.g.d. The sewers being of the separate system, the necessary changes were made in the septic tanks to convert them to aeration tanks. They were of such a size as to give a satisfactory detention of slightly greater than five hours for the average dry-weather flow.

The new plant at De Kalb, Ill., is a good example of an old septic tank being used for sludge storage. The old plant consisted of a septic tank 30x40x 10 ft. deep, and intermittent sand filters. The new plant is of the separate sludge digestion type, with trickling filters for secondary treatment, followed by final clarification. With a design population of approximately 16,000 the engineers used a 40-ft. diameter by 15-ft. effective depth sludge digestion tank, which gave slightly less than 1.2 cu. ft. per capita sludge capacity. This tank is equipped with a mechanism and provisions are made for heating and controlling the reaction so as to get a well-digested sludge in the minimum length of time. The digested sludge will be drawn at frequent intervals during the year and stored in the old septic tank until such time as it can be put on the drying beds. Considerable saving resulted in the cost of the digestion unit by using this scheme. Only a portion of the existing sand beds were required for sludge drying and the remainder were abandoned.

Princeton, Ill., affords another example of utilizing an old septic tank for digestion. The old plant consisted of a septic tank followed by trickling filters, while the new plant is of the separate sludge digestion type followed by activated sludge. The trickling filters were abandoned in the new layout, but the septic tank was remodeled for sludge digestion purposes, and new aeration tanks were built to accommodate Simplex aerators.

The plant at Lancaster, Wis., is similar to some of the plants already described. There were two existing septic tanks, portions of which were converted to aeration tanks for the activated sludge process, and the other parts converted to settling and sludge digestion tanks.

A small plant at Oconomowoc, Wis., had an existing septic tank. The new plant was designed for chemical precipitation, and a clarifier installed for removing the sludge which was pumped to the old tank for storage.

Barrington, Ill., had an old septic tank, intermittent sand filter type plant, while their new plant is of the Imhoff, trickling filter type. The old units were used to treat the excess storm flow. By using this scheme a saving resulted in the design of the new plant which only needed to be of sufficient size to treat the sanitary flow. The old units are not used frequently enough to cause an unsatisfactory condition about the plant.

The existing septic tank for a small plant at Rochelle, Ill., was rebuilt to form a sludge digestion tank for a separate sludge digestion, trickling filter type plant. A new plain hopper-bottomed settling tank was constructed.

Fostoria, Ohio, had an old Imhoff tank which was utilized in the design of their new separate sludge digestion plant. The flow-through compartment was removed and hot water coils were installed for heating the sludge.

When a new plant was designed for Fond du Lac, Wis., there was an old Imhoff tank in service, but the site was considered inadequate and an entirely new one chosen. The old tank is still in place and will probably be used at some time in the future for treating industrial wastes. The new plant is of the separate sludge digestion type with provision for gas collection and heating of the sludge. Provision has also been made for adding secondary treatment at such time as it is considered necessary.

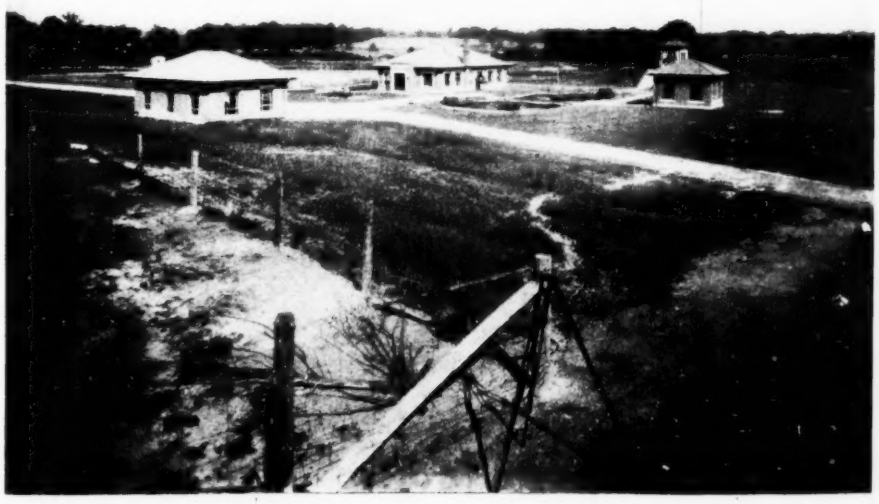
There was a small Imhoff tank at Waukesha, Wis., but it was abandoned when a new site was chosen for the separate sludge digestion, trickling filter plant.

The design for the Jacob E. Decker & Sons plant at Mason City, Iowa, was an unusual case of plant revamping. The old plant was of the activated sludge type and consisted of a fine screen, a preliminary clarifier, aeration tanks and a secondary clarifier. The new plant is of the trickling filter type and consists of a fine screen, flow equalizing tank, preliminary clarifier, primary filter, intermediate clarifier, secondary filter and final clarifier. In the new design the fine screen was used as before. One aeration tank was converted to a storage tank for equalizing the flow, while the other is to be used for future sludge storage. The old final clarifier which had the required detention for preliminary clarification, in the new scheme, was used for that purpose. The air blowers were used in connection with the washing of the preliminary filter. All of these units fit in very nicely with the new layout.

Conclusions.—Of the eleven plants discussed, seven consisted of septic tanks, and three of Imhoff tanks for preliminary treatment. Those using secondary treatment had either intermittent sand or trickling filter beds.

In the new designs for the seven plants having old septic tanks, five were of the separate sludge digestion type, one was of the Imhoff tank type and one employed chemical precipitation with sludge storage and drying. For secondary treatment three used the activated sludge process and two adopted trickling filters, while two did not require secondary treatment.

Acknowledgment.—This paper was presented at the 11th Sewage Treatment Conference at Ames, Iowa.



Salem, Ohio, Sewage Plant After Revamping

Commercial Problems in the Water Business

By L. M. ANDERSON

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THE public relations and advertising divisions have their place in the water business, but nowhere can friends or foes be made so readily as in the commercial division, where periodical contract is necessarily had with the consumer.

The contract, as well as meter reading, collection and adjusting divisions, all have their important place in their relations with the public, who always expect the best treatment by the employees of the utility.

A Common Cause of Misunderstanding.—Every effort should be made to secure a signed contract for water service before the use begins. One of the great difficulties which tends to produce misunderstanding and ill feeling is that many will neglect to make application before beginning the use of the service. Someone will move from the premises without ordering a shut-off and a closing bill and a new customer will begin using water with no thought of making application therefor. The meter is read, the bill rendered under the old tenant's name and no attention is paid to it by the new tenant until a shut-off notice has been given, then the trouble begins.

If a guarantee deposit has been made by the previous tenant it is very easy to make a deduction from the deposit for the amount of the bill; if no deposit, then the only alternative is to proceed to collect from the new tenant who has substituted himself for the old one by using water without first making application and signing a contract.

Guarantee Deposits. — Requiring a guarantee deposit to secure the payment of water bills is important and requires discrimination without apparent favoritism.

It is good practice to require deposits in each case from renters, where the owner of the property will not sign a guarantee contract, and also from owners who are always in a chronic state of arrears.

Meters should be read for billing as nearly as possible each thirty days.

Prompt Rendering of Bills Important.—Meter readers should be trained to notice any great difference in present as against average readings. If there should be a noticeable difference in the consumption, whether more or less, and no apparent change in the use of water on the premises, it should be reported immediately so that an inspection can be made and the consumer notified if a leak exists, or perhaps the meter is not operating and requires overhauling.

Prompt notice of unusual bills saves many misunderstandings and if adjustment is to be made, it is better to do so immediately than to wait until some future time, when conditions may have changed sufficiently to make it next to impossible to arrive at a fair adjustment. Prompt rendering of bills is very important.

If there has been an excessive use and a large bill is the result, the consumer should receive his bill promptly, thereby giving him an opportunity to correct the trouble if it exists.

Making Adjustments.—Adjustments should not be made unless the large bill is the result of an accident or from some cause not under the user's control. If you begin to make adjustments and allow rebates, except for waste not under the control of the consumer, you will never know where to draw the line.

The person who insists upon a rebate and states that it is not the amount of money but the principle involved, is usually not sincere. More than likely the reduction in the bill is what he wants and he will be satisfied with nothing else.

Bills should be rendered promptly. The sooner a bill is in the hands of the average person, the sooner it will be paid. The longer the delay in getting bills out, the greater will be the loss from uncollectible bills.

Meter readings should be checked when extensions are made by the office force and bills made and mailed as soon as possible.

Adjustments should be made at the office whenever possible, as it is easier in most cases to come to an understanding there than at the home of the complainant. "A dog under his own wagon is hard to handle."

The selection of inspectors and adjusters should receive serious consideration. These men must be neat in appearance and should possess considerable poise and be of sound judgment. It will be part of their routine to stand abuse without retaliating.

Billing and Collecting.—Collections by mail are the cheapest, although collectors can hardly be dispensed with as a visit to the premises may be required in many cases when no reply is received from a mailed bill. The customer may be temporarily absent or there has been a change of tenants.

In case there is a new tenant, it is necessary to learn, if possible, the whereabouts of the previous tenant owing the bill, and also to have the new tenant sign up for the use of the water.

The stub bill system is very good for a follow-up of collections. If the bill is not paid in say, fifteen days after mailing, the delinquent stub can be detached and mailed or sent out by a collector. By this system it is only necessary to check over the unpaid accounts, which are readily seen, as the stubs on the paid bills are detached at the time the payment is posted and the unpaid ones only remain.

If the business is large enough and there are many accounts, the tabulating machine card system works admirably in checking unpaid accounts, as well as in many other particulars.

Charges for Unusual Items.—Charges for unusual items, such as damaged meters, and bills of that nature should be discussed with the person responsible for the damage and an understanding reached, if possible, before the bill is rendered. Otherwise a great deal of time is consumed and expense incurred before the bill is collected.

The regular monthly bills are not troublesome to collect, but those for the unusual items and for closing bills are hard to collect and expensive.

The consumers' bill should be simple, easily understood and without too much text.

The subject of district or sub-offices is always a problem in large communities.

The consumer cannot understand why an office should not be maintained in his locality for his convenience.

It is more efficient and economical to keep the accounts and bills at a central or general office, rather than to divide this work by doing some of it at a branch office. Just how much should be done at a branch or district office is a question.

It does not pay to maintain a very high priced, efficient force at a small office, but rather one understanding the detail of the business.

Whether anything more than taking orders and collecting bills should be done at a branch office is debatable.

It is difficult to obtain prompt reports of orders and collections unless a messenger service is maintained, and, if the territory covered by the utility is large, the expense of such service is out of proportion to the amount of business usually done at a branch office.

Much has been said regarding shut-offs for delinquent bills. It is difficult to establish an inflexible rule in this respect; there are so many exceptions worthy of consideration.

If it were possible to secure the proper legislation in this state making the charge for water a lien against the property served, there would be little necessity for shutting off water on account of delinquent bills. There is, however, quite a difference of opinion in regard to such legislation.

Acknowledgment.—The foregoing is a paper presented before the California Section of the American Water Works Association.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
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Cracks in Filter Beds

NEARLY everyone operating a filter plant has observed cracks along the sidewalls of the sand beds. In addition to this, the surface cracks occasionally cover the entire filter bed, sometimes to the extent that there is scarcely a square inch of surface area that does not contain a crack. Sidewall cracks in many plants are readily noticeable at all times of the year, but the size of the cracks usually vary considerably for different seasons or for changes in the characteristics of the water. All filter beds have a tendency to pull away from the sidewalls as the loss of head increases if there is any shrinkage whatever of the beds. Perhaps it would be more correct to say the beds are pushed from the sidewalls, for this is what actually happens. Sometimes the cracks along the sidewalls are so small they are not readily noticeable and the operator may believe none are present, but in most instances there is at least a small crack.

Sidewall Cracks May Extend Nearly to the Gravel.—Filters will be found varying from no cracks to cracks along the sidewalls 1 to 1½ in. wide at the top. Where there is a wide crack the sand may be pushed away from the sidewall for a depth of 60 to 80 per cent of the total depth of the sand. This may be demonstrated by taking a thin piece of sheet iron and running it down between the sand and the sidewall. This pushing away from the sidewall, together with the surface cracks, may produce a new filtering surface within the cracks much greater than the original sand surface.

Shrinkage of Sand Beds Cause Cracks.—When cracks form it is evident there is shrinkage or settlement of the beds. In our discussion of the filter bed in the January, 1930, issue, it was stated that the sand, after being suspended during washing, settles about as loosely as is possible for it to be. Even with this looseness of the sand bed there is not much shrinkage during filtration when the sand is perfectly clean and free from coatings. Each grain touches other grains and there is no way of applying a pressure that will cause it to be forced together to any material extent. If the bed could be jarred or vibrated so as to produce a slight movement of the sand the grains would work together more tightly and form a lesser volume, but this is not practical nor necessary for filter beds.

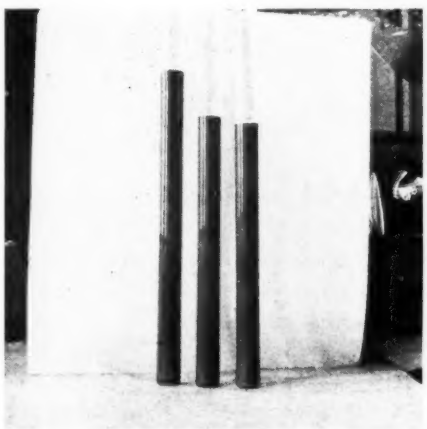


Fig. 1—Settlement of Sand from Filter Bed by Compacting

Figure I illustrates how sand containing a coating may be compacted. All three tubes were filled with water, then the sand was allowed to drop into the tubes, displacing part of the water. The tubes were filled to the same level with sand. The one on the left was allowed to stand just as filled. The one in the middle was taken in the hands, held in a vertical position, and rolled in such a manner as to produce a slight movement of the sand grains. The rolling was continued for about 1 minute. The one on the right was rolled in the same manner as the center one, but in addition it was bumped by holding the tube in a vertical position and dropping it about ½ in. on a wooden surface. This compacted it just a little more than the center one. The tube on the right has a volume only 84 per cent of its volume before compacting. Clean sand of the same size could be compacted about 10 per cent by the same procedure. There is a difference of about 6 per cent in the looseness of settling of clean sand and sand with a coating. It so happens that this 6 per cent was approximately the actual shrinkage of the bed from which the sand was taken. Whether or not this is a factor that may be determined in like manner for all beds, the writer is unable to state.

A loss of head of 8 ft. over the initial loss produces a pressure of about 500 lb. per square foot on the bed. This is not much of a load, and we should expect clean sand to shrink very little under this pressure. One-eighth inch probably is about the maximum settling for a clean bed of sand of average size and 24 in. deep, consequently a coating on the sand grains is a prerequisite for cracks to form. It is well known that the sand grains in many filtration plants have a coating. The writer described the coating on the sand grains of the Baltimore Filtration Plant in 1924.* The coating on the Baltimore sand was so thick that removing the coating from a given volume of sand caused it to shrink about 16 per cent in volume for sand that was the average of the bed. For the finer sand near the surface, removing the coating caused it to shrink about 30 per cent in volume.

Coating on Sand Grains.—There was so much organic matter in the coating on the sand grains at Baltimore that a flame would come from a small amount of the coating inserted in a hot muffle furnace. The residue after ignition was largely silica, aluminum oxide, iron oxide, and manganese. Table I gives a mineral analysis of the coating.

Table I—Analysis of Coating from Sand Grains Where Beds Form Cracks

	Per cent
Loss on ignition, largely organic matter	30.1
Insoluble in HCl, largely SiO_2	20.2
Iron oxide, Fe_2O_3	6.4
Aluminum oxide, Al_2O_3	36.7
Manganese dioxide, MnO_2	6.1
Calcium oxide, CaO	.3
	99.8

The treatment of the water influences the composition of the coating, for all coatings will contain a large amount of the coagulant and other suspended matter. Silica and organic matter appear always to be present in considerable

*Baylis, John R. Sand-bed studies at Montebello water filters, Baltimore. Eng. News-Record, 92: 13, 516-22, March 27, 1924.

quantities in gelatinous coatings, and while much of this may come from the suspended matter, part of it may be due to growths on the sand grains. Most fairly hard coatings, except calcium carbonate coatings, which the writer has observed contain iron or manganese, frequently both. It is believed that the coagulant and silt is largely entrapped in the coating and that it does not form the bonding material. The precipitate in settling basins does not bind itself together very toughly, even though it may stand for years, and there is no reason to believe that this alone will build tough coatings on sand grains.

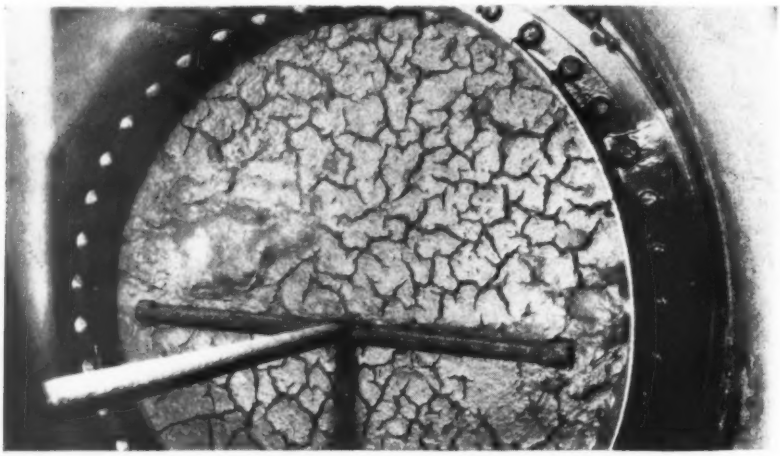


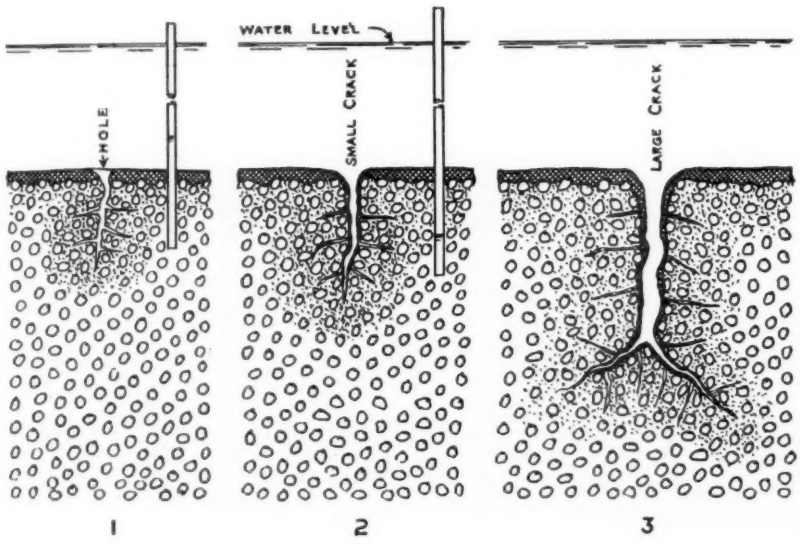
Fig. 2—Surface Cracks in a Small Filter Bed

Tough Coatings Build Up Slowly from Compounds Supersaturated in the Water.—Tough coatings build up slowly and more than likely are deposited from compounds supersaturated in the water. If there is a slight supersaturation of manganese in the water it will deposit on the sand surfaces, and once a coating has started the manganese will deposit more readily on the precipitated manganese and make the deposit thicker. Coatings built up in this manner are usually fairly tough. Should an iron compound be used to coagulate the water and conditions be favorable for complete precipitation of the iron, the precipitated material will not bind to the surfaces of sand grains. A slight amount of iron in solution, however, will cause iron to bind to the sand surface. The necessity for the binding materials in the coatings to come from compounds supersaturated in solution is illustrated by the formation of calcium carbonate coatings on sand grains in many softening plants. When calcium carbonate is precipitated from a hard water by the addition of lime, and after the precipitation has slowed up, the water is carbonated to where it is just saturated with calcium carbonate, it will not deposit on the sand grains regardless of how much of the precipitate may be carried on to the filters. If it is left supersaturated it will coat the grains with calcium carbonate, even if no precipitated material is left in the water as it goes to the filter beds.

Any solid exposed to water will, in most instances, eventually become coated with a slimy material. Most of us who have slipped on a submerged board or rock realize just how slippery a surface under water may become. The cause for the slimy coatings is not known definitely, but bacteriological or other biological growths are thought to be responsible. Such coatings usually contain considerable silica; however, biological growths may be the cause of the silica being deposited. It is known that diatoms have the power of precipitating silica to form a silicious shell. Whatever be the cause, gelatinous silica will deposit on most surfaces exposed to water. Sometimes it takes weeks or months for the coating to become thick enough to make the surface slippery to the touch; at other times only a few days are required. Occasionally the coating will form on surfaces exposed to water which has been chlorinated to the extent that it does not seem possible for bacteria to grow, indicating that biological growths on the surfaces are not necessary.

There is the same tendency for gelatinous coatings to form on the surfaces of the sand grains as on other surfaces, though washing usually keeps most of it rubbed off. The coarser the sand the greater is the abrasion during washing. This, probably, is why fine sand grains tend to coat more easily and more thickly than larger grains. Thick coatings usually do not form unless there is some material other than silica that binds the coating to the sand. This may be organic matter, iron, or manganese—sometimes all three. Wolman and Powell† probably were the first to attempt to explain the cause of cracks along the sidewalls of filter beds, though filter operators had been aware of cracks being present almost from the beginning of rapid sand filtration. They though that syneresis might offer an explanation of the shrinkage of the beds. The writer has never agreed with this view; however, this is of minor importance, for their article was a very valuable contribution to the literature on filtration. It inspired others to study filter beds, and we now know much more about the subject than we did 10 years ago.

Surface Cracks.—Surface cracks, as a rule, form only for short periods of time in most filtration plants. Very likely there are exceptions to the rule, but this is the case in all filters observed by the writer. Sometimes clogged places in the sand bed near the gravel will cause surface cracks to form when they otherwise would not and when there is no indication of the clogged area being present. In this



FORMATION OF SURFACE CRACKS IN FILTER BEDS

Fig. 3—Sketch Showing How Surface Cracks Form in Filter Beds

†Wolman, Abel, and Powell, S. T. The surface shrinkage of rapid filter sand beds. Eng. News-Record, 85: 5, p. 210, July 29, 1920.

ase the cracks will be in certain spots and they will not cover the entire surface as is the case for the surface cracks now being discussed. Figure 2 gives a good illustration of the surface cracks in a small filter bed. The camera was pointed almost straight downward, and the photograph shows about what one sees when standing over a filter and looking down on the bed. The 1 in. pipe just above the sand surface gives some idea of the scale of the photograph. The pipe was placed there for a surface wash, but it had not been used prior to taking the photograph.

The writer has observed filter beds which run for months without surface cracks forming, then almost of a sudden they start forming. The condition shown in Fig. 2 may prevail for a month or more, then the cracks may stop forming and there may be another period of a few months in which none or only a few cracks form. Sometimes the surface becomes so badly cracked there is scarcely a square inch that does not contain a crack.

Surface cracks form when the coagulated matter is neither very weak nor very strong. It is, of course, essential that the filter bed shrink as the loss of head increases, for if this was not the case cracks could not form regardless of the strength of the coagulated matter. The toughness of the coagulated matter varies greatly in many waters from winter to summer. In winter the coagulated matter is frequently quite weak, penetrates deeply into the sand beds, and the filter runs are long. In the summer the coagulated matter is frequently very strong, there is practically no penetration, and the filter runs are short. Neither of these conditions produce surface cracks, it is the moderately strong coagulation that occurs frequently in the spring and in the fall that causes surface cracks to form.

This is apparently what happens when surface cracks form: The filtration is first largely in the surface layer. After the loss of head has increased 1 to 3 ft. over the initial loss, holes start forming through the surface. This was discussed and illustrated in the January, 1930, issue of *Water Works and Sewerage*. Sketch 1 of Fig. 3 also partially illustrates how the holes are formed through the sand surface. There is a rush of water through the holes, which starts branching off in every direction as soon as it passes the clogged area at the top of the bed. Where there has not been much penetration of the coagulated matter prior to the break the clogged area may not extend more than ¼ to ½ in. below the surface. Due to the high velocity of the water in the channels leading beneath the surface, most of the suspended matter is carried forward a slight distance before it is deposited, sometimes ½ in. or more. A clogged area is formed around the channel, and instead of the pressure being exerted on the area of the channel only it is exerted on an area frequently hundreds of times larger. The clogged area does not form a definitely defined spherical membrane with all the head exerted on the membrane, but the pressure head gradually diminishes through the sand in all directions from the channel. If there is a loss of head of 3 ft. over the initial loss before a crack forms, this head must be killed in some manner. One foot of this may be friction loss in the channel and branches of the channel before the area where most of the clogging takes places is reached. The other 2 ft. of head will be pushing sideways as well as downward on a clogged area that may equal the pressure on a hollow sphere 1 in. in diameter. Where shrinkage can take place in the sand, a pressure is finally reached that forces a crack in the sand. Once a crack starts it is easy for it to keep extending longer and deeper, due to the side pressure on the newly formed surface. There is the same tendency to force the sand apart and make wide cracks as there is to force the sand away from the sidewalls of the filter.

Sketch 2 in Fig. 3 shows about what takes place when a crack is first formed. It may open for a length of 1 in. or more on the surface and may extend ½ in. or more below the surface. The rush of water through the sides soon form clogged surfaces in the crack and the pressure opens the crack wider, deeper and longer. Sketch 3 in Fig. 3 shows a large crack that may be ¼ in. or more in width and may extend 2 to 4 in below the surface. This illustrates cracks about the size of the larger cracks in Fig. 2. The photograph in Fig. 4 shows some of the larger cracks to be fully ½ in. wide at the top. Some of these cracks extended a foot or more before running into other cracks started from other points. This is a condition when the coagulated matter is fairly tough and only a few cracks get started. If the coagulation had been weaker, there probably would not be 2 sq. in. of surface without a crack.

One condition very favorable for the formation of surface cracks is for the top 2 or 3 in. of sand to be more heavily coated with a gelatinous film, and to be more loosely packed than the balance of the bed. The first cracks that form are usually along the sidewalls and if the sand is of nearly equal looseness for the entire depth the side cracks may force the sand away from the sidewalls to the extent that they resist the formation of the surface cracks, especially in the area near the sidewalls. When the sand a few inches below the surface can be compacted or forced together only a very little the cracks along the sidewalls cannot open so wide. In other words, there is an unequal shrinkage of the sand at the surface and that a few inches below the surface. This is actually the condition in most rapid sand filter plants, for the smallest sand grains and those with the thickest gelatinous coating are the lightest and settle near the top of the bed after being suspended during washing.

If the formation of holes through the surface layer of the filter bed is an essential, we may ask why weakly formed coagulation does not produce cracks. There are so many holes through the surface in this case and they start forming at such a low loss of head that very little head builds up at any point in the bed. When the coagulation is tough practically all loss of head may be in the surface layer, but with the weak coagulation it may be a gradual loss through several inches of sand.

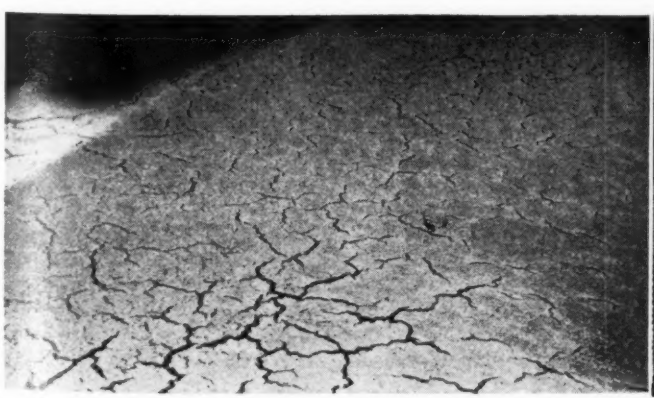


Fig. 4—Large Surface Cracks in a Filter Bed

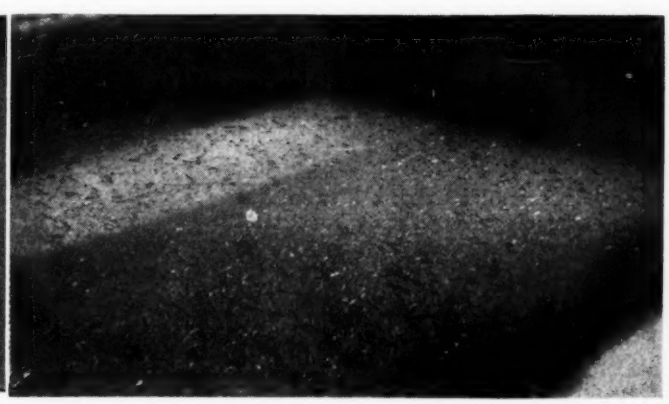


Fig. 5—Flakes of the Surface Layer Not Broken Up by Washing

The writer has observed one condition that produces surface cracks when the flocculation is tough. This is shown in Fig. 5. Unfortunately the cracks do not show very well in the photograph, for the filter surface contained numerous cracks. The surface layer formed so toughly it was not entirely broken in pieces so small they were washed away when the filter was washed. There were pieces of the surface layer about ⅛ in. in thickness ranging in size from very small particles to flakes having an area of 3 to 4 sq. in. Most of these flakes remained

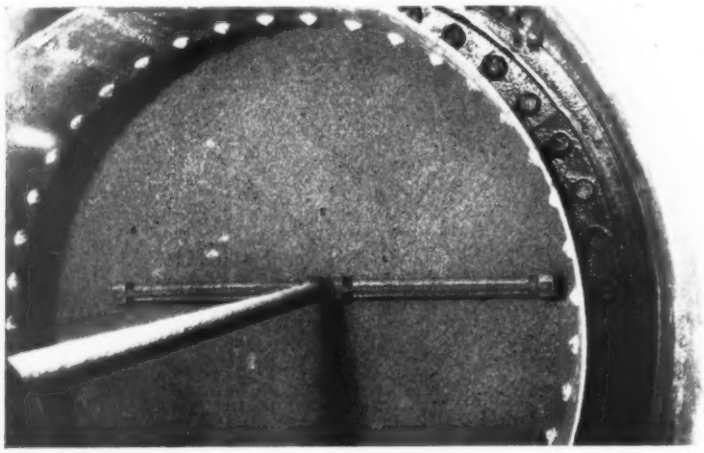


Fig. 6—Filter Bed After Using Surface Wash

on or near the surface of the sand. The flakes were left sticking into the sand in all directions, many of which were nearly at right angles to the sand surface with about one-half of the flake projecting above the sand. This is what shows most distinctly in Fig. 5. Where each flake projected through the sand, except where it lay nearly flat, a crack formed. The cracks always formed between the sand and the surface of the flake originally on top; that is, they never formed between the sand and the surface of the flake originally against the sand. The reason for this is not known. Somehow the newly formed surface layer would form a hole along this surface of the flake more easily than through other parts of the surface. This condition is believed to be very unusual and perhaps has not been observed by many.

Effect of Cracks on Filter Beds.—When cracks form the coagulated matter is usually so tough there is not much danger of the flocculated matter passing the sand beds, except along the sidewalls where the cracks are quite deep. In some instances cracks within or around clogged places also extend nearly to the gravel and may allow coagulated matter to pass the bed. The side cracks are much more dangerous than the surface cracks, for the surface cracks rarely extend more than 3 to 4 in. below the surface. Cracks lengthen the filter runs, for they produce a larger filtering surface. In some instances they may be regarded as being beneficial, for the filters do not have to be washed so often. They are believed to aid in the formation of clogged places by allowing large amounts of coagulated matter to concentrate at points beneath the top of the filter bed. This is especially true for cracks along the sidewalls. Clogged places are formed along the sidewalls of many filters, even when they do not form in other parts of the beds. In fact, very few filter beds will remain free from clogged places along the sidewalls all the time. The formation of clogged places will be discussed in a later issue. It is evident, however, that they should not be allowed to form and anything that will prevent their formation deserves serious consideration.

Cracks in filter beds may be eliminated or prevented from forming by keeping the sand grains so clean there will be practically no settlement of the bed as the loss of head increases. A surface wash appears to be the most practical means of keeping the sand clean all the time. This also will be discussed in a later issue. Compare the photograph in Fig. 6 with that of Fig. 2, and the value of the surface wash should be apparent. Fig. 6 is the same filter as shown in Fig. 2 after using the surface wash a few times.

Water Department Encourages Winter Construction.—The Water Department of Detroit, Mich., recently let a contract for laying about 9,000 ft. of 66-in. steel pipe, and in order to encourage the contractor to work all winter they are paying a premium of approximately 10 per cent of the contract price for each foot of pipe laid in the trench before April 1, 1930.

Small Cities in Kansas Have Water Systems.—Seventeen cities in Kansas, each of less than 300 population, have water systems. The smallest is Manter, population 148, which installed a $7,500 system in 1928.

Device for Sampling Sludge

An ingenious arrangement for securing samples of sludge from Imhoff tanks was used at the experimental sewage testing plant at the University of Illinois.

Samples of sludge were taken from a deep Imhoff tank and from a shallow Imhoff tank weekly and analyzed for bio-chemical oxygen demand, hydrogen demand, hydrogen-ion concentration,

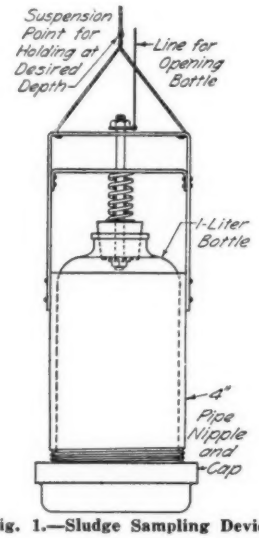


Fig. 1.—Sludge Sampling Device

and per cent moisture content for the purpose of comparing the sludge from the deeper tank with that from the shallower tank in regard to these qualities.

The apparatus for the taking of sludge samples consisted of a wide-mouthed glass bottle of one liter capacity. The bottle was wedged within a 4-in. diameter pipe nipple. A wrought-iron cap screwed on the lower end of the nipple added sufficient weight to sink the bottle, and also served as a protection. The mouth of the bottle was closed by a rubber stopper held in place by a spring. The device is illustrated in Fig. 1.

In sampling, the bottle was lowered to the desired depth and the stopper was removed, by means of a chain, until the bottle was filled. The stopper was then allowed to spring back in position. The return of the stopper into the bottle made it possible to secure samples of sludge without the danger of introducing additional moisture into the sample as it was being drawn up.

Another device used for the taking of samples and for determining the sludge level consisted of an ordinary pitcher pump, on the suction side of which was attached a length of hose. The hose could be lowered to any desired depth and a sample taken by means of the pump. This device was especially useful in getting the sludge level due to the fact that the sludge was not disturbed when care was exercised in pumping and in lowering the hose.

Slag as a Medium in Sewage Trickling Filters

Results of an Inspection of Various Filters Together with a Suggested Specification for Blast Furnace Slag When Used in Filters

AN investigation of the use of crushed blast furnace slag in sewage trickling filters was made recently by Charles C. Hommon, Consulting Sanitary Engineer, Canton, O. The study covered 48 sewage filters, 37 of which had slag as the filtering medium. The results of the study have been set forth by Mr. Hommon in a report, which was published early this year by the National Slag Association. The following notes are taken from the report:

This investigation was made to determine the suitability of crushed blast furnace slag for use in sewage trickling filters. It is based upon the performance of all the slag trickling filters that could be located in this country. Thirty-eight such filters were visited together with eleven trickling filters in which aggregates other than slag were being used. The latter filters were inspected primarily for the purpose of making comparisons of the unloading ability of the different aggregates.

Unloading Ability.—With respect to the ability of crushed slag filtering material to unload, the inspection of the plants served to show that practically all of the older filters had retained a relatively large amount of organic matter. The same condition existed in filters containing other aggregates. In many instances, especially in the smaller plants, operating records were not available to indicate when and how completely the filters had unloaded. In others there was good evidence that the filters did unload at periodic intervals. These few instances of known unloading periods, together with the satisfactory operating records of practically all of the slag filters visited, indicate that the roughness of slag is not an important item insofar as the periodic sloughing of the organic deposits is concerned.

It is difficult even to estimate for comparative purposes the amount of organic solids contained in the many existing slag filters and in the filters filled with other types of aggregates. It may be said, however, that a great many of the older filter beds, regardless of the character of the medium, were dirty. Undoubtedly, all of the filters must have at least partially unloaded at periodic intervals, otherwise they would have become entirely clogged, but it appears that natural sloughing is not sufficient to maintain them in the best of condition in a majority of cases. Naturally, the load, character of sewage and other factors must be taken into consideration when comparing one filter with another, all of which render difficult the drawing of conclusions.

Control of Organic Deposits.—To determine whether or not it is possible to control the organic deposits that normally collect on sewage filters, considerable attention has been given to the operation of the filters at Canton, O. The two years of service has indicated that the slag filtering material will unload at indefinite intervals but that the deposits can be controlled within narrow limits (without lowering the efficiency in any respect) by (a) periodic resting and drying, or (b) flooding of the filters. It also appears that the use of chlorine will materially aid in causing the filters to slough.

Data on the efficiency of these beds while in a dirty condition are not available because of the care which has been exercised throughout the operation of the filters. It is therefore not possible to state the increase in efficiency that may have resulted from the cleanliness of the medium, but the entire absence of surface clogging (which is common in so many filters regardless of the type of filtering material) and the high degree of purification afforded the Canton sewage lead one to the conclusion that a clean filter is to be preferred to a dirty one.

More accurate determination of the unloading ability of the different aggregates and any advantages one material may have over another will require some research work through the use of a sectional test filter in which the different kinds of filtering material may be subjected to the same treatment.

Size of Aggregates.—Filters were found where the aggregate ranged from quite coarse to fine and all combinations of sizes were noted, sometimes within the same filter. In most instances where fine material was found the lack of evidence of disintegration strongly indicates that the fine material was placed in the filter at time of construction. This belief is strengthened by finding fine material in some of the newer filters where disintegration could not have played an important part, and it applies not only to slag but to other aggregates. One is therefore forced to the conclusion that sufficient attention has not been given to the inspection of the filtering material at the time of construction.

The surface slag in some of the filters as well as the surface stone in the limestone filters showed evidence of having failed to varying degrees. In the case of slag the failures were of three general classes, namely, flaking, splitting and disintegration, the former being the most common. The failures in the limestone filters were of two general types, namely splitting and disintegration, splitting being the more prevalent. It is not possible to state the degree of failure in definite terms because of the lack of knowledge concerning the original condition of the material; however, the fact that one of the older slag beds has a satisfactory service record of 21 years indicates that the failures have not been very serious.

Consolidation of Filtering Material.—Time would permit only a superficial examination to determine whether consolidation had occurred. That it had not occurred to any appreciable extent was indicated by the general appearance of the slag filters, the test pits that were dug, and the absence of any excessive clogging. In the few instances where slag filtering material had been removed, its condition indicated that consolidation had occurred only where excessive deposits of fine material existed. These areas (even though they had not solidified) would have become clogged and been rendered useless by organic deposits. Because of this fact the cementing action of slag is not considered a serious matter. There was no evidence found to indicate that slag reasonably free from dust and fines showed any tendency to cement.

It appears that development of the filter-moth fly (Psychoda alternata) is a logical occurrence in sewage trickling filters. They were found in varying numbers in practically all types of filtering material and had given rise to difficulties in beds filled with both rough and smooth aggregates, leading one to believe that the type of filtering material plays no part in their development.

Conclusions.—From the field investigation and from laboratory data the following conclusions may be justifiably drawn:

(1) The field investigation, in conjunction with sodium sulphate tests on samples collected from existing beds, show that crushed blast furnace slag is a durable material when employed as a sewage filtering medium.

(2) In a few of the filters, portions of the surface material had been affected by (a) flaking, (b) splitting and (c) true disintegration or crumbling.

(3) With the exception of 1 slag bed and 1 stone bed, this effect was not of sufficient magnitude to materially alter the size of the aggregate or affect operation of the filters. This conclusion is

based on the fact that few pieces of slag were found to have failed by true disintegration, and that the flaking resulted in only a negligible quantity of fine material.

(4) When exposed to air and sewage, individual pieces of slag containing much metallic iron may ultimately disintegrate, due presumably to the rusting and consequent expansion of the iron.

(5) Blast furnace slag as commonly used for sewage filters does not contain a sufficient amount of metallic iron to be objectionable.

(6) Improper sizing and gradation were found in all types of filtering material. Absolute adherence to correct size limitations will prevent such a condition.

(7) The efficient equipment now employed in preparing air-cooled slag is adequate to crush and screen the material so that it will meet any reasonable specifications.

(8) There was no evidence to indicate that crushed slag in the sizes now commonly specified for sewage filters will cement or consolidate.

(9) In the few instances where consolidation had occurred, it had been caused by excessive accumulations of fine material in localized areas, due to improper handling of the filtering material at time of constructing the filters.

(10) There is no greater amount of organic deposits retained in slag filters than in those filled with other types of material.

(11) The rough texture of blast furnace slag does not prevent the periodic unloading of filters.

(12) Laboratory tests in conjunction with the field survey show that the suitability of a slag filtering material can not be determined by any of the following factors: absorption, specific gravity, weight per cubic foot, loss by abrasion or chemical composition. It is also believed that hardness, toughness and cementing value have no bearing.

(13) Slag filters effect a very satisfactory stabilization of the organic compounds in sewage.

(14) It does not appear that the type of filtering material has any direct bearing upon development of the filter-moth fly.

(15) The field investigation indicated that sewage trickling filters (regardless of type of filtering material) would be benefited appreciably by controlling the amount of organic deposits retained in the filter. This can be accomplished by (a) periodic resting and drying, (b) flooding, or (c) chlorination.

(16) Finally, the information secured through this investigation indicates that crushed blast furnace slag is a suitable and desirable aggregate for use in sewage filters.

Factors Considered in Drawing Up Specifications for Slag Filtering Material.—This survey of sewage plants brought to light a number of details, apparently neglected at the time of construction, which have reacted detrimentally to the operation of the respective plants. Had a simple and efficient specification been prepared and strictly adhered to, it is believed that in many instances a more satisfactory filter would have resulted.

The following factors should not be considered as covering all the details to be provided for in a complete set of specifications governing the construction of a sewage filter. They apply only to the filtering material and the method of placing it in the bed. Some of the factors have been studied in the light of circumstantial evidence, and are therefore subject to revision as more evidence becomes available.

Important Factors:

The results of this study indicate that the following items are important factors in specifying slag as a sewage filtering material:

(1) The filter must at all times permit ready passage of the applied sewage and free circulation of air, and the medium should be of such size that it will afford the maximum surface area consistent with reasonable economy. It therefore follows that proper sizing and grading of the coarse aggregate are of paramount importance.

(2) The aggregate must be durable, otherwise the destructive effects of weathering, periodical wetting and drying, and freezing and thawing will cause disintegration, which, if in appreciable quantity, will result eventually in an unsatisfactory medium.

(3) The manner in which the aggregate breaks when crushed is also of importance, roughly cubical shapes being preferable.

(4) The method of placing the aggregate in the filters has a decided effect on later operation. If it is dumped in one spot and then distributed over the bed, fines will accumulate at that point, resulting in a tendency to clog the filter.

(5) The engineer in charge of the work and the producer furnishing the material must fully realize the importance of (a) absolute adherence to the specifications governing size of material, and (b) handling the material so as to prevent the formation of fines through breakage. If the aggregate is stock-piled at the disposal plant site, care must be taken so that, on re-handling, nothing but slag is placed in the filter.

For the reasons outlined above, it is believed that the items of durability, sizing and grading, cleanliness, and proper methods of placing the aggregate in the filter at time of construction will result in much improvement in work of this kind.

Unimportant Factors:

The following factors are believed to be unimportant in drawing up a specification for slag filtering material:

(1) Specific gravity, weight per cubic foot, absorption, resistance to abrasion, and chemical composition, for the reason that no relation was shown between these properties and the behavior of the aggregate in the beds.

(2) Toughness and hardness, since the aggregate is not subjected in a sewage bed to influences which would test these properties. The same applies to resistance to abrasion.

(3) Cementation, since cementation can occur only in material so finely-divided as to preclude its use in sewage filters.

(4) Surface Texture. Theoretically a rough material should be superior to a smooth one, since the rough surfaces afford better facilities for the attachment of finely-divided matter. Some engineers, however, believe that roughness tends to retain the solids to the point of causing excessive clogging. Practical experience does not support this belief, since (a) clogging was found with all types of aggregate, including ravel and traprock, and (b) satisfactory results have been obtained in practically all cases where rough aggregates have been employed.

Suggested Specifications for Blast Furnace Slag When Used as the Medium in Sewage Trickling Filters

Filtering material shall consist of crushed blast furnace slag having angular, roughly cubical fragments. The slag shall be furnished by a reputable producer fully equipped with crushing and screening facilities sufficient to assure the production of the material as specified and in such quantities as will be required for the prompt execution of the contract. A thorough inspection of the plant facilities and of the finished product shall be made by the engineer before final approval.

Sampling:

From the finished product (stockpile, bin or car) the engineer shall select for the required tests a representative sample of slag of the size to be used in the filters.

The slag shall meet the following requirements:

Durability:

The durability of the material shall be determined by 20 cycles of the sodium sulphate test prescribed by the American Association of State Highway Officials (U. S. Dept. of Agriculture Bulletin 1216, 9-28) except that the sample shall consist of 50 or more pieces of slag of the size to be used in the filters. The following conditions of test shall govern:

1. Any piece of the material shall be considered as having failed in the test which registers disintegration (a) By splitting into 3 or more pieces or (b) By crumbling to such an extent that there is 10 per cent fine material (by weight) passing the No. 4 sieve (sieve opening 0.187 in.).

2. Any sample registering failure in excess of 10 per cent of the pieces tested shall be considered of doubtful soundness and the test shall be repeated on a new sample. A second doubtful result will justify rejection of the material.

Metallic Iron:

All slag aggregate, after crushing, must be passed over a magnetic separator at the slag plant in order to remove pieces containing metallic iron.

Size and Gradation:

The material shall be graded within the following limits as indicated by round hole laboratory screens:

1¼ to 2½ in. size:	Passing 2½ in.	—95-100%.
	Passing 1¼ in.	— 0- 5%.
	Passing ¾ in.	— 0- 2%.
2½ to 3½ in. size:	Passing 3½ in.	—95-100%.
	Passing 2½ in.	— 0- 5%.
	Passing 1 in.	— 0- 2%.

NOTE: The 2½ to 3½ in. size is recommended, but the engineer may choose and write into his specifications either of the above sizes.

Method of Placing the Aggregate:

The material shall be placed in the filter in such a manner as to preclude (a) the formation of fines through breakage and (b) segregation through improper handling.

Coagulation Basins, Baldwin Filters, Cleveland

Design Provided Straight Flow Through Basins Without Baffles and Sharply Sloping Floors

THE coagulation basins of the recently completed Baldwin filtration plant of Cleveland, O., have a number of interesting features that are departures from ordinary practice. The provision of a straight flow through the basins with no baffles has proved entirely satisfactory. The use of a sharply sloping floor in the basins for the dual purpose of reducing the height of the outside walls and facilitating the cleaning of the basins also has proved to be of practical importance. A very complete description of the Baldwin filtration plant, written by Messrs. J. W. Ellms, G. W. Hamlin, A. G. Levy and J. E. A. Linders, appears in the February Proceedings of the American Society of Civil Engineers. That portion relating to the coagulation basins is reprinted herewith.

The coagulation basins shown in Fig. 1, extend for a distance of nearly 500 ft. from the east wall of Baldwin Reservoir. Data pertaining to these basins are given in Table I:

The four basins have an average water depth of 14 ft. 11 in., varying from a minimum of 9 ft. 4 in. to a maximum of 16 ft. 6 in. The water enters at one end of the basin over a weir and under a stilling-baffle and is taken off at the opposite end over a similar weir. Provisions have been made for by-passing the coagulation basins through a conduit along the west side of the basins, connecting Gate-Houses Nos. 1 and 6 (see Figs. 1 and 2). An inlet conduit forming the south wall of the basins furnishes the waterway through which the water flows to Gate-Houses Nos. 2 and 3. The former controls the flow to Basins 1 and 2, and the latter to Basins 3 and 4. There is one 60 by 84-in. sluice-gate for each basin. The control from the basins, at the outlet end, is effected through Gate-House No. 5 for Basins 1 and 2, and through Gate-House No. 4 for Basins 3 and 4. At the outlet end, there is one 60 by 84-in. sluice-gate for each basin.

The by-pass control of the coagulation basins is effected through Gate-Houses Nos. 1 and 6, where the water may be shut off entirely from the north and south conduits. When the by-pass is in use all the water flows through two 60 by 84-in. sluice-gates

Table I

Over-all area, in square feet, including conduits and gate-houses (457 ft. by 747 ft.)	341,379.00
Area, in square feet, between weirs inside of basins (108 ft. 7 in. by 661 ft. 6 in.):	
Basin No. 1	70,500.00
Basins Nos. 2, 3 and 4 (each)	70,900.00
Depth of water, in feet:	
Maximum	18.50
Minimum	9.30
Average	15.00
Capacity, in gallons, each basin	8,200,000.00
Detention period between weirs, in hours	4.70
Velocity of flow through basin, in feet per minute	2.36
Velocity of water in south conduit, in feet per second (water surface elevation, 242.5)	2.17
Velocity of water in north conduit, in feet per second (water surface elevation, 241.5)	2.42
Maximum velocity of water through sluice-gates (in feet per second)	2.43
Effluent and influent weirs:	
Maximum elevation	240.50
Minimum elevation	237.00
Length of weirs in each basin, in feet	77.00
Stilling-baffle:	
Elevation of top	242.50
Elevation of bottom	237.71
Overflow weirs:	
Length, in feet (each basin)	28.27
Depth, in feet, above weir to discharge 41,250,000 gal. daily (each basin)	0.77
Elevation of top	243.00
Elevation of floor:	
At center line	223.50
At sides	232.70
Elevation of flow line	242.00
Elevation of intrados at crown	245.50
Distance, in feet, from floor to crown of arch at the center of the basin	22.00
Total number of 20-in. square columns in the four basins, 15 ft. 9 in. on centers	1,041.00

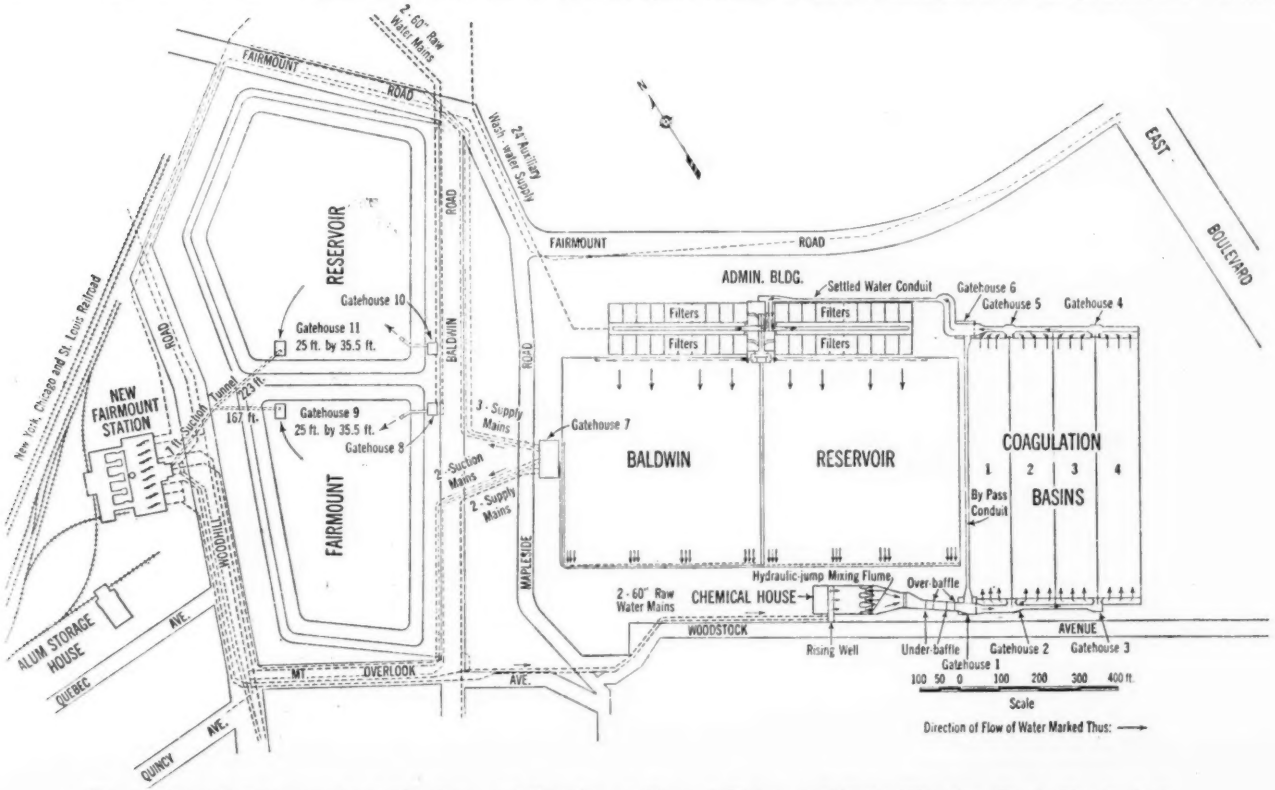


Fig. 1.—General Arrangement of Structures and Direction of Flow of Water at Baldwin Filtration Plant, Cleveland, O.

in each of the gate-houses. Under the condition of maximum flow, a velocity through these gates of about 3¾ ft. per sec. results.

Each basin is of reinforced concrete construction with groined arch roof, reinforced sloping floor, and independent column footings. The floor consists of two parts, a sub-floor 4 in. thick and a finished floor 8 in. thick, the latter being reinforced with ½-in. square deformed bars on 15-in. centers in both directions. The sub-floor butts against the walls and column bases. The finished floor rests on a ledge at the walls and at the column footings, and all floor joints are filled with asphalt to prevent leakage. The sloping floor performs the dual function of facilitating cleaning and of reducing the height of the wall sections.

All conduits (Fig. 2) were designed as rigid structures. Stability was investigated under conditions allowing an upward hydrostatic head of one-third the height of the water in the basin. In the case of the north conduit, recognition was taken of the possible removal of the earth backing at some future time to take care of adjacent construction, and the conduit was designed accordingly. At the by-pass conduit, the usual barrel arch was designed as a cantilever, extending from the roof of the conduit. Because of the frequency with which it has been observed that arch action does not always take place between the barrel and groined arches, all dividing walls between the basins were designed on the basis of an unbalanced arch thrust. The groined arches are tied together in groups of four and reinforced with two ½-in. square bars on either side of the crown. All manholes are tied securely to the groined arch roof with steel reinforcement extending well into the arches. This is required particularly in the case of the manholes supporting the mechanism for the mud-valves, in order to prevent frost action between the roof and manholes lifting the mud-valves off their seats in the floor of the basin, and thus permitting water to leak into the drains. The columns supporting the roof are of five different lengths, varying from 10 ft. 8 in. to 17 ft. 11 in. In the 10 ft. 8-in. and 12 ft. 8-in. columns, no reinforcement is used. The remaining columns are reinforced with four ¾-in. square bars, with ¼-in. round ties spaced 12 in. center to center. Six stiffening walls are placed in each basin, parallel to the long axis, and near the center of the basin.

Each coagulation basin is provided with six mud-valves for cleaning and draining. These valves permit flow into a lateral drain placed immediately under the floor of the basin and along the longitudinal axis. Each drain is connected into the main drain header near the north end of the basin.

To assist in cleaning, 2½-in. hose gates spaced about 50 ft. from center are provided on each side of each basin. They are connected to 6-in. water mains placed on the long walls of the basins.

Expansion joints are placed in the coagulation basin walls at intervals of approximately 60 ft. and at the junction of the walls with the gate-houses. The water-seal at these joints is made with a 16-in. strip of copper, approximately $\frac{1}{16}$-in. thick. About 7 in. of the strip is embedded in the concrete on each side of the joint with the remaining 2 in. formed into the shape of a V to provide for contraction. To permit expansion, the concrete surfaces at the joint are separated by ⅜ in. of asphaltic fiber cement. Subsoil drains, connected to the main drain, were laid under the floors of the basins and around the outside of the walls.

Meeting of New York State Sewage Works Association

The winter meeting of the New York State Sewage Works Association was held in New York City on Jan. 18, 1930. The program included an inspection of the 40 million gallons daily capacity sewage screening plant located beneath the surface of West and Marginal Sts. at Canal St., New York.

The attendance at the luncheon at the Hotel McAlpin was 89. There followed a very interesting technical program including talks on the sewage disposal problems of the Metropolitan District by Arthur S. Tuttle, W. W Young and J. Ralph Van Duyne. In teresting round table discussions upon practical topics, including the pollution of beaches, dangerous wastes affecting sewers, curb and gutter inlets, tide gates, the desirability of sewers under each sidewalk and the handling of screenings, were led by Professor Earle B. Phelps, John F. Skinner, J. C. Collyer, John C. Riedel, J. F. Sanborn and H. B. Cleveland. The program was arranged by a committee headed by Richard Gould.

The president, Kenneth Allen, announced that the next meeting of the association will be the annual meeting and is scheduled to be held at Albany, N. Y., on May 10, 1930. He appointed Earl Devendorf, chairman of the committee on arrangements for this meeting.

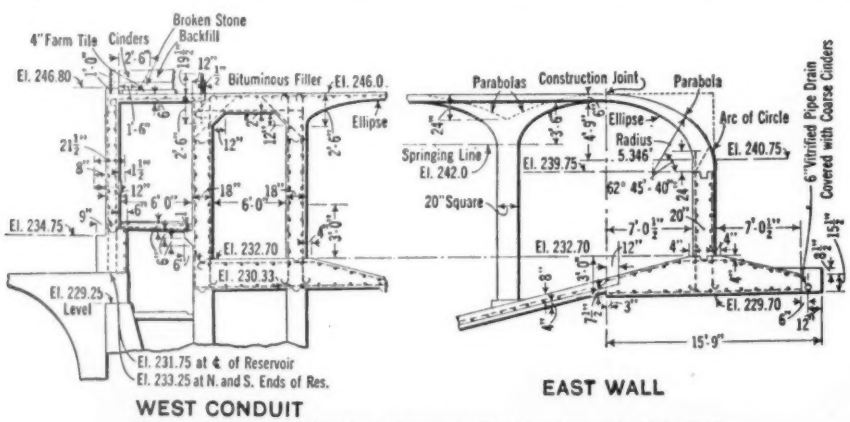


Fig. 2.—Congulation Basins; Details of West Conduit and East Wall

Vegetation for Protection of Slopes from Erosion

The planting of slopes is recognized as a satisfactory means for protecting slopes against erosion. A. R. E. A. specifications for the use of vegetation for this purpose are given in the Manual as follows:

The slopes shall be graded to whatever final surface is desired.

Vegetation suited to the conditions existing in the territory where slopes are to be protected, shall be selected. This may consist of sod transferred from other locations; sod grown on slopes, as a result of seeding; vines such as honeysuckle, myrtle, etc., and dwarf species of shrubbery.

If the material of the slope is not fertile, it may be given a dressing of loam, manure or commercial fertilizer. As manure generally contains weed seeds, care must be taken, where applied, to prevent troublesome weeds from going to seed.

In order to prevent newly laid sod, transferred from other locations, from slipping, it is necessary to hold it to the slopes by use of wooden pins not less than 7 in. long, spaced not more than 2 ft. apart.

A good seed mixture for well watered parts of the country consists of about 50 per cent alfalfa, 25 per cent Kentucky blue grass and 25 per cent of red-top seed. Care must be taken to inoculate the alfalfa seed, if the soil has not previously grown alfalfa. Sweet clover is also effective at many locations, and in some sections of the country Bermuda grass is found to be best.

Honeysuckle vines are effective at many locations, the recommended spacing of plants being 2 ft. apart.

A Taxless City.—Colby, Kan., a municipality of 1,900 inhabitants, has been a taxless city since 1928 on account of profits from the municipal light and water plant. The surplus in the treasury at the present time amounts to about $49,000.

SEWAGE DISPOSAL WORKS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. DOWNES, Associate Editor

Supervising Engineer, the Plainfield and Dunellen, N. J., Sewage Disposal Works

Sludge Digestion

THERE seems to be so much misunderstanding about this matter of sludge digestion that we take this opportunity of restating a few homely facts with regard to the subject even at the risk of accusations of triteness or of carrying coals to New Castle. A mere codification of the essential known facts, shorn of scientific reservations and qualifications, should help to clarify the situation.

All living things consist of combinations of the elements, carbon, nitrogen, hydrogen, oxygen, together with smaller quantities of such elements as sulphur, phosphorous and lime.

Immediately life is extinguished in any such combination, or such a combination is excreted from a living organism, these elements become the prey of other living organisms which appropriate these elements to their own use by a process of selection either leaving free, or excreting in new combinations, such portions of the various elements as they can not use.

This appropriation of the elements to the maintenance or growth of living organisms is spoken of as a biological process as distinguished from purely chemical processes, such as the rusting of iron.

While all biological processes involve chemical reactions, the fact that disintegration of dead organic matter can be prevented by sterilization (the killing off of all living things which could come in contact therewith) is evidence that the disintegration of organic matter is essentially biological.

Such disintegration of organic matter in sewage is what we are interested in, and know as "Sludge Digestion."

The purpose of sludge digestion is to reduce the volume of waste material to be disposed of and to secure such combinations of the elements as will not produce objectionable odors.

The process is endless; the living organisms which make the original attack on the dead waste material in turn give up the ghost, and their elements are attacked by others which eventually die and are attacked and so on. Fortunately, about the time that the practical limit of shrinkage in volume has been reached the elements are arranged in non-odor producing groups which are more suitable to the maintenance of plant life than of animal life. Here the interest and responsibility of the operator ceases with turning over the residue to the agriculturist for use as a fertilizer, or to the bargeman.

What the operator is interested in is arriving at this stage in the shortest possible period of time, because the shorter the time the smaller need be the required storage space. Where the storage space for digesting material is limited (but not less than 40 times the volume of sludge collected daily), it is comparatively simple to keep the process in control under favorable conditions, but once the storage space is full before the proper stage of digestion is reached, troubles come thick and fast. Let us then investigate the subject of favorable conditions.

All organic material will eventually reach the desired stage even if left to itself under almost any conditions, but we have in mind one plant where the freshly settled sludge was pumped to tanks of some 20,000 cu. ft. capacity each, each tank being completely filled with the green sludge and left to itself. The result of such operation was, that digestion had made practically no progress at the end of two years. Such results, obtained at a time when the subject of sludge digestion was very p o o r l y understood, gave "Separate Sludge Digestion" a reputation which it is very hard to overcome even with our present day information.

If spread in a thin layer, exposed to the atmosphere, the organic material which constitutes sewage solids would reach the desired stage of disintegration previously described by one route; if held in a large mass with the atmosphere entirely excluded it would arrive at an equally satisfactory stage of disintegration by another route. The first route is called the "Aerobic" digestion because the living organisms which make the attack require atmospheric oxygen for their existence. The second route is called the "Anaerobic" because the organisms involved do not require atmospheric oxygen.

If the material is in considerable bulk, yet with some of its surface exposed to the atmosphere, progress will be first by one route then by the other and much time will be lost. We must, then, determine on one route or the other and make every effort to keep the process moving in that direction.

The aerobic or atmospheric route is out of the question because its success would depend on spreading the material so thinly that unthinkable areas would be required and, obviously, the opportunity for spread of odors would be very great.

If, on the other hand, we adopt the anaerobic course, the depth at which we may store any part of the material is unlimited. We may therefore confine it within a reasonable area, an area so small that it is entirely feasible to cover the surface to protect it from the atmosphere, and we are then assured of uninterrupted progress toward a given end point by way of a predetermined route.

In all sewage there may be said to be two general classes of material; one consisting of paper and vegetable garbage in which the element carbon predominates, and one of animal origin in which the element nitrogen is the dominating influence.

The disintegrating organisms which normally predominate at the time when the sewage reaches the disposal plant are particularly aggressive in attacking the former class of material and any sulphur which may be available for their use. As a result the first evident effect of the attack is the arrangement of the elements carbon, hydrogen and oxygen into groups which constitute acids, of which the most familiar is carbonic acid. The sulphur also is arranged with hydrogen and oxygen to form acid, sulphuric acid, and with hydrogen alone to form hydrogen sulphide.

If allowed to remain in contact with the sludge these acids interrupt and slow up the process which we are attempting to hurry forward. If they are neutralized the elements which make them up become available as food for other organisms which will carry on the process.

It is also true that some of the organisms last mentioned combine the

elements in their waste products in such a way as to produce the alkali necessary to neutralize the acids, nitrogen uniting with hydrogen to form ammonia.

It is, then, only necessary to maintain a sufficient excess of old sludge (sludge which is being attacked by the ammonia producers) in order to provide automatic neutralization. With automatic neutralization the process is continuous and comparatively rapid.

Not only do the organisms attacking the older sludge produce ammonia as a by-product, but they also arrange a combination of carbon and hydrogen in the form of methane or marsh gas, a highly inflammable gas with a heating value about equal to that of the illuminating gas which we buy from the public service companies.

We know that at temperatures below 60° F. there is very little biological activity, in fact at 56° we enter the range of temperatures which electric refrigerator manufacturers refer to as the "Preserving Zone" because activity is so slow that food will keep for a long time below 56°. From 60° up to 82° activity increases very rapidly with each degree of increase in temperature and a biological process such as that in which we are interested will reach a given stage or end point in a correspondingly shorter time.

Now if, in the case cited, instead of pumping 20,000 cu. ft. of green sludge into an open tank and leaving it exposed to the air at whatever temperatures might be seasonable, the operator had known, and applied, the information here set forth the whole process would have been completed inside of 40 days instead of being barely started in two years time. In order to accomplish this very desirable end it would be necessary to:

(1) Add the fresh sludge gradually to older sludge on a fixed daily schedule, to keep the alkali producers in preponderance.

(2) Seal the surface of the sludge from contact with the air by covering to exclude both oxygen and cold.

(3) Make use of the inflammable gas, produced by the organisms, for the purpose of raising the temperature of the sludge to the point where the organisms are most active.

(4) When all of the preceding precautions have been taken, action becomes so violent that the evolved gas, passing upward through the mass, sets up a mild agitation which is beneficial in preventing isolated developments contrary to the general trend of the process and thus further speeds the process by perhaps 10 per cent.

As stated at the beginning of this article, we have, in the interest of clarity, foregone scientific reservations and qualifications. For instance, referring to the number (1) of requisites for rapid sludge digestion above, our scientific friends will doubtless rise up to state that, "To keep the alkali producers in preponderance" is only part of the story. This is true and it is equally true, that to encompass all the reservations and explanations would require another article as long as the present one, and so on with each of the other items until we should become befogged in a mist of words. We can only refer those who would dig deeper into the subject to the many excellent papers and books which are now available.

No distinction is here made between separate sludge digestion and digestion in Imhoff tanks or in septic tanks, because we are discussing the essential process involved and that is exactly the same in any of the three cases. However, because of lack of control, it is impossible to apply the information which we have at hand to the two latter.

Septic tanks have the advantage from the sludge end (but at the cost of the quality of the effluent) of disgorging much that would be digested with difficulty. Imhoff tanks, though designed expressly to eliminate this feature, retain it to a considerable extent.

We may collect gas from Imhoff tanks, but the nature of the gas vents, and their multiplicity, make this rather unsatisfactory, and it is entirely impractical to keep the floating solids in Imhoff gas vents submerged.

The temperature in the digestion compartment of Imhoff tanks is to a great extent governed by the ground temperature, and, in the Northern States at least, is down in the zone of preservation below 56° for a far greater portion of the year than it is above 60° F., where active digestion can be expected. Heating of the digestion compartments of Imhoff tanks would undoubtedly be very helpful if a practical method of application could be found.

The most favorable distribution of solids in an Imhoff tank by means of proportioning the velocity of flow of sewage somewhat to the area of the tank, is the nearest that we can approach to control of the old sludge-green sludge ratio in the case of such tanks. There are bound to be inequalities in deposition of sludge in tanks of such section and such inequalities lead to the setting up in isolated areas of a course of disintegration contrary to the general trend and, therefore detrimental.

From the above we see that it is only with separate sludge digestion that we can control and make optimum all of the conditions which are conducive to rapid odorless digestion, and that while exactly the same principles are involved in the case of double duty tanks we are almost helpless in their application.

With the English Sewage Works Managers

The 1928 Proceedings of the Association of Managers of Sewage Works (the latest yet available) contain various items which will be interesting to American plant operators.

Discussing sedimentation tanks, Mr. W. S. Jackson, River Inspector, West Riding Rivers Board, states that the general practice in design of sedimentation tanks of the continuous flow type is to make the width one-fourth the length but feels that better results would be obtained with the width one-third the length. This writer speaks very highly of a type of tank in which the flow is alternately under and over a series of baffles, stating that the flow is absolutely uniform. The sludge is collected in steep hopper bottoms and thus effectively removed out of the sedimentation zone, it is removed from the hoppers once or twice daily. He states that the only interruption of service of these tanks from "blockages" has been "due to some adventitious matter, such as buckets and bricks."

* * *

Mr. Walter Scott, speaking on the "Bulking of Activated Sludge," makes the following statements: "Bulking of sludge is not due to under-aeration or to over-aeration, since there is no difference in the D. O. in the effluent." . . . "A sludge which has got into the state known as bulking is equally efficacious as a purifying agent as a non-bulking sludge. The drawback is the difficulty in settling and the increased volume which have to be removed as surplus sludge."

"Bulking is due to the kind of material being treated"; milk wastes and starch wastes are particularly prone to bulk. In support of this statement he gives results of an experiment in which, sewage, sewage plus 1 per cent milk and sewage plus 1 per cent starch, were areated over a period of 27 days. Sludge volumes were read off daily after one hour sedimentation and the settled sludge made up to 500 cc. with the respective mixtures after the supernatant had been decanted.

Starting with from 13 to 14 per cent volume of solids; plain sewage increased in bulk of solids to 20 per cent on the 19th day where it remained, varying between 19 and 21 to the end of the experiment.

Starting at the same point, sewage plus 1 per cent milk grew to 47½ on the 17th day and jumped to 75 per cent on the 18th and after reduction to 19 per cent on the 18th day by dilution increased to 95 per cent on the 27th.

Starting likewise with sewage plus 1 per cent starch, the volume increased to 86½ on the 16th day and after reduction to 18 per cent by dilution on that day increased to 52 on the 25th, 90 on the 26th and 95 per cent on the 27th day.

Mr. Scott further states, "The chief

point of interest in treating tannery wastes is the instantaneous disappearance of tannin. We have found that with sewage containing 10 g.p.g. of tannin, the tannin immediately disappears on coming into contact with activated sludge, and on immediately filtering this mixture the filtrate is free from tannin."

* * *

For cleaning tanks which have to be drained for the removal of sludge the Proceedings describes a machine built on the lines of a diminutive road scraper and powered with a 1½ hp. gasoline motor.

Progress of the Federation of Sewage Works Associations

The Annual Meeting of the Board of Control of the Federation of Sewage Works Associations was held in New York City on Tuesday, Jan. 14th.

The reports of the secretary and of the business manager indicated progress for the Federation's first year far beyond what the most optimistic had dared to hope for.

The reports show that at the end of the year 1929 there were 13 active affiliated, sectional organizations with a combined membership of 1,081. Non-member subscriptions brought the total paid circulation of the Federation's Journal well above 1,200.

The surprising thing is that in one short year the Federation's Journal is on its feet, financially, the entire printing bill being met by the income from the Journal.

A resolution was passed in appreciation of the excellent work of the editor, Dr. Mohlman.

Another resolution was passed in appreciation of the work of the business manager, Mr. Wm. W. Buffum, and of the aid extended by the Chemical Foundation.

The great number of foreign subscriptions which have been received brought up the question of sections in foreign countries. Negotiations looking to the formation of a section or conference in Great Britain or some plan of affiliation with present British organizations was authorized as a result of numerous British inquiries along this line.

Water Power Development in Canada.—With the installation during the past year of new water power equipment totalling almost 378,000 H. P. there is now installed for all purposes a total of 5,727,162 H. P. and by the completion of work now under way this figure will be increased to more than 6,075,000 H. P. before the end of 1930 while an additional installation of over 3,000,000 H. P. is in active prospect.

Water Department Emergency Service Trucks

When the water works at Portland, Me., was taken over in 1907 by the Portland Water District the construction and maintenance work was being done by the use of three teams. Today, 18 automobiles and trucks are being used. The operation of this fleet has resulted in giving prompt attention to troubles and complaints. An important unit of this fleet is an emergency service truck, which is used especially for emergency troubles. The following description of this truck was given by James W. Graham, Treasurer and General Manager of the District, in a paper presented at the last annual meeting of the New England Water Works Association.

The truck consists of a 1¼-ton Graham Brothers truck. On each side is a tool box running the full length of the body, which also serves as a seat to carry extra workmen when necessary. In the tool boxes are carried implements such as picks, shovels, wrenches of various types, rubber coats and boots, gate books, electric hand lamps and extension cords, jacks, and tow lines. In fact, all tools necessary to handle water-works emergencies, such as breaks on main lines, distribution mains and hydrants, are included. The jacks and tow lines are used for assisting passenger automobiles, or trucks, which have become stuck in soft trenches or have run into open trenches. The truck is also equipped with a Kohler 2,000-watt automatic electric generating plant. The generator is capable of operating three 250-watt searchlights and several hand lights. It can also drive a ditch pump with a capacity of 70 g.p.m. against a head of 20 ft.

The truck is used for all emergency work and responds to all second-alarm fires within the territory supplied by the district for the purpose of closing gates in case of breaks on mains or hydrants. It also assists the fire department with flood lights when desired. In August, 1929, this truck responded to a general alarm fire where a loss of more than $500,000 was involved. For several hours its flood lights greatly assisted the firemen in their work. On several occasions the truck has been used on night emergency work, and the lights have greatly assisted our workmen. The total cost of the truck with equipment was $2,000.

Prompt Payment of Water Bills in New York City Required.—Two important changes in the law which shortens the time in which water bills in New York City must be paid have been made. Instead of being allowed three months from Jan. 1, property owners who pay on a frontage basis must now meet their bills by Jan. 31. Delinquents will be penalized 7 per cent on the bill from Jan. 1 to the date of payment, instead of the old graduated penalty of from 5 per cent to 15 per cent, which reached its maximum on June 30. Owners who pay on a meter basis must now meet their bills on or before the end of the month following the month in which the bill is sent, instead of the quarter following the quarter in which the bill was received. Penalties of 7 per cent will be charged against delinquents from the date of receipt. Bills received during the third and fourth quarters of this year may be paid without penalty up to Jan. 31, 1930.

Sewer Rental Rate in Ohio.—In 1928 there were seventeen cities in Ohio that financed the operation of their sewage disposal works by the sewer rental plan. The average minimum annual charge was $4 per sewer connection. Payment was usually made quarterly, as in rendering water bills.

Emergency Truck of Portland Water District

The Twelve Permanent Cyclones and Their Anticyclones

Weather Characteristics Explained by Electromagnetic Whirl Theory

By HALBERT P. GILLETTE

IN the October, 1928, issue of this magazine I presented an electron-whirl theory that explains many terrestrial and celestial phenomena. In that article I gave the location of the centers of 12 permanent cyclonic whirl-centers on the earth, and stated that each of these cyclonic whirls produces an anticyclone. I have made some minor changes in the location of a few of the mean positions of the centers of these 12 permanent cyclones, whose corrected positions are given in Table I.

As stated in my article a year ago, free electrons tend to rotate about magnetic lines of force, and if they exist in a fluid the fluid is propelled by the rotating electrons. The electrons in such whirls become concentrated so as to form whirling cylinders in which the electrons grow fewer in number as the center of the cylinder is approached. Hence, we may speak of cyclonic air-whirls as whirl-belts.

It should be added that all cyclonic whirls ascend, bend over and descend, forming an inverted U, and that they resemble a horse-shoe magnet, both as to shape and as to magnetic polarity. Looking at the two ends of a horse-shoe magnet, the north pole is where the electrons are rotating anticlockwise, and conversely as to the south pole.

The 3 permanent cyclones around the arctic circle rotate anticlockwise, whereas the 3 around the antarctic circle rotate clockwise. The same is true of the small migrating cyclones. In cross-section the cyclonic and anti-cyclonic whirl-belts are elliptical. The long axes of the 6 elliptical circum-polar cyclones lie nearly on the meridians, but somewhat inclined thereto; whereas the long axes of the 6 elliptical equatorial cyclones lie nearly on the lines of latitude. As a cyclone ascends the long axis of its ellipse turns slowly, so that by the time the air reaches the earth as an anticyclone that axis has turned through an angle of 30 to 45 degs.

It should be noted that the interior of a great whirl-belt, whether cyclone or anticyclone, is a place of relative calm, and consequently of small rainfall. The Sahara Desert, for example, lies within the largest and most powerful of the 12 great cyclones, A. Hence the Sahara is literally walled in by a hollow-cylinder of rotating electrons that prevent the entrance of moist sea air.

When the sun's north pole points most nearly earthward about Sept. 8, the 3 arctic whirls (a, b and c) are ordinarily most powerful, because electrons migrate to that region. Six months later (Mar. 8) the 3 antarctic whirls (d, e and f) are ordinarily most powerful. But the magnetic forces of the planets cause marked departures from these dates of major activity of the 6 whirls.

The four whirls nearest the equator (A, B, D and F) change their direction of rotation every 6 months; whereas the arctic whirls always rotate anticlockwise and the antarctic whirls rotate clockwise. The effects of these directions of rotation upon the general air currents will be discussed in a later article.

There are two great magnetic fields on all the planets and on the sun, an upper and a lower field. Each of these two "shells" of electrons contains at least 12 permanent whirls. The lower "shell" rotates rapidly with the planet's solid or liquid mass. The upper "shell" rotates very slowly and in the opposite direction to the rotation of the upper shell. It is the upper "shells" of the planets that cause most of the weather disturbances that are not purely seasonal. Sunspots aid in these non-seasonal disturbances, but are of less importance than the direct effect of the magnetic fields of the planets.

The reason for two layers or "shells" of free electrons in celestial bodies is this: Electrons are set free from atoms as temperature rises and as pressure falls. The highest temperatures and greatest pressures are near the center of a celestial body, whereas the lowest pressures and temperatures are remote from the center. The effect is to produce two shells of maximum density of electrons. In the earth the lower shell accounts for the ordinary magnetic effects on the compass needle, whereas the upper shell (Heaviside layer, 75 miles above the earth) accounts mainly for the earth's production of sunspots, and it also has a profound influence upon the migration of electrons and the generation of cyclonic storms.

Although there are several magnetic fields in each of the two shells of electrons (upper and lower), and although their relation to similar fields on the sun and planets affects the distribution of electrons in the earth and its atmosphere, which distribution in turn affects air movements and rainfall, still the weather problem is not made insuperably complex. By the electron-whirl theory I have been able to explain so many facts about weather, often quantitatively, that I am now convinced that it offers a means whereby the weather riddle, or rather congeries of riddles, can be completely solved.

In Encyclopedia Britannica, under Climate, will be found charts that show 3 of the 12 permanent cyclones of Table I and 6 anticyclones corresponding to the 6 circumpolar cyclones.

Charts of ocean currents show the mean positions of many of these permanent air whirls; the topography of the globe serves to locate every one of the centers of the 12 permanent cyclonic whirls, which are evidently the same for the molten matter beneath the earth's crust as for the air immediately above it.

Clayton's "World Weather," Huntington's "Earth and Sun" and his "Climatic Changes," and Brook's "Climate Through the Ages" all contain charts of permanent barometric highs and lows that will be found to be in accord, as far as they go, with the data given in Table I.

Table I.—Location of the Mean Centers of the 12 Permanent Cyclones

Center	Latitude Degrees	Longitude Degrees
A	17.5 N	0° W
B	17.5 N	120 E
C	40 N	132.5 W
D	2.5 S	67 W
E	29 S	145 E
F	10 S	135 W
a	66.5 N	180 W
b	66.5 N	30 W
c	66.5 N	75 E
d	66.5 S	135 W
e	66.5 S	30 W
f	66.5 S	75 E

Note: The symmetrical arrangement of these whirl centers is noteworthy, a hexagonal system being apparent.

Indiana Water Works Men Meet in March.—On account of the conflict with spring vacation at Purdue University the date of the meeting of the Indiana Section of the American Water Works Association has been changed to March 20 and 21. This meeting, as originally planned, will be held at Purdue University, Lafayette, Ind.

Los Angeles County to Store Excess Flood Water

Plan Would Cause Flooding of Large Acreage and Replenishment of Underground Reservoirs —Period of Wet Years Anticipated

A TOTAL of 22,500,000,000 gal. of water will be added daily during flood-water periods to Los Angeles county's naturally stored underground supply by the capture and infiltration of flood water that now runs off into the ocean and is lost, according to a plan proposed by E. C. Eaton, chief engineer of the Los Angeles County Flood Control District. The plan is described as follows in a recent issue of the Los Angeles Times.

The sinking process is through a system of confluent canals branching from main streams over adjacent spreading-grounds. The flood water is taken via one main or several canals from the river or wash conveying it and percolates partly through the canal bottoms and partly through the acreage over which it spreads from the canal ends, into the underground storage places. The system is so devised that certain canals can pick up the excess water spread by some of the ditches and direct it to other parts of the spreading-ground to expedite infiltration and prevent flooding. Where necessary, levees are located to protect roads and land adjacent to the spreading-grounds. The flood water is taken from the main streams at specified levels to prevent interference with the normal stream flow. Such a method, it is contended, not only will enable the desired infiltration but likewise will form a protection against flood-water damage.

If all of a single year's vagrant water in the county were put underground it would be enough to take care of the country's water needs for about three years, Mr. Eaton estimates.

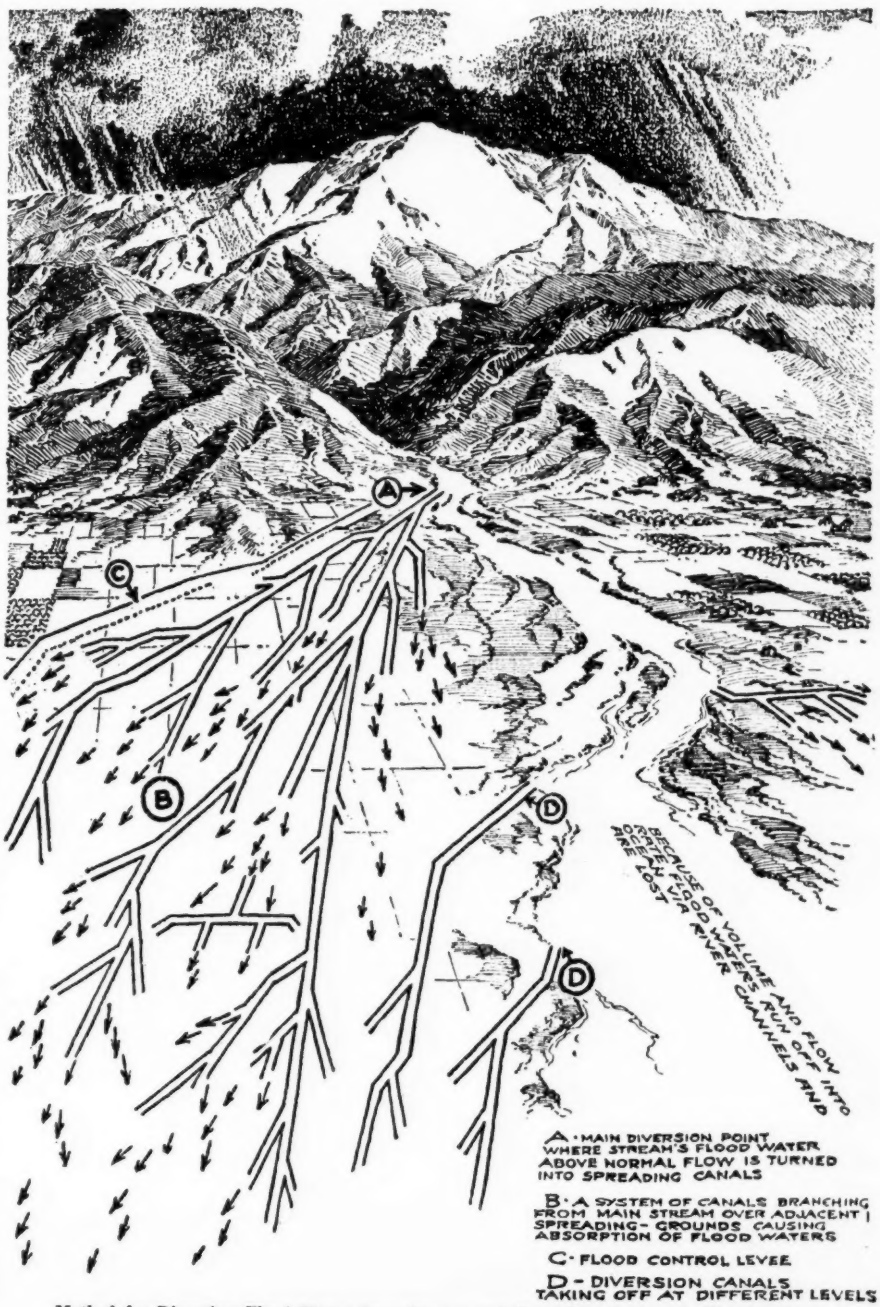
As Water Reserve.—However, Mr. Eaton's plan does not intend a replenishment of the subsoil water supply in lieu of any of the pending projects to bring in additional water to this region from the Colorado River and other contemplated sources, but as an extensive water reserve or insurance while these projects are being consummated and after they are completed.

A preliminary suggestion in this connection has been submitted to the Board of County Supervisors by Mr. Eaton involving the use of unoccupied and untilled lands adjacent to several streams in the county as infiltration areas. This method is working successfully on 600 acres adjacent to the San Antonio River in the northeast part of the county, where it has been tried out to determine its feasibility for the entire county. Mr. Eaton expects to have the complete details of his plan worked out by July 1, next, as part of his new and comprehensive flood-control program including surface dams and other works that he considers essential.

Wet Years at Hand.—This is a particularly good time, he declares, to prepare for the underground replenishment because this county is about to have a new period of wet years in which the rainfall likely will be above normal. Such expectation is based on well-defined cycles indicating that several wet years follow eleven years or so of more or less subnormal precipitation here. In fourteen years there have been only two years of normal or super-normal runoff in this locality.

The water that wastes into the ocean is conveyed via stream channels that drain territory over which the flood water flows too rapidly or is of too great a quantity to permit of complete absorption. The larger part of the mountain drainage and the county's plateau uplands finds its outlet via the Los Angeles and San Gabriel River systems.

Extensive Reservoirs.—Conditions are


A
B
C
D
D
BECAUSE OF VOLUME AND FLOW OF SEVERAL FLOOD WATERS RUN OFF INTO ARE LOST
A - MAIN DIVERSION POINT WHERE STREAM'S FLOOD WATER ABOVE NORMAL FLOW IS TURNED INTO SPREADING CANALS
B - A SYSTEM OF CANALS BRANCHING FROM MAIN STREAM OVER ADJACENT SPREADING-GROUNDS CAUSING ABSORPTION OF FLOOD WATERS
C - FLOOD CONTROL LEVEE
D - DIVERSION CANALS TAKING OFF AT DIFFERENT LEVELS

Method for Diverting Flood Water from Stream and Spreading It Over Infiltration Area

especially propitious here for underground water storage. Nature has given Los Angeles county the priceless boon of absorbent strata that form the largest and best natural subterranean reservoirs in the country. They have the additional advantage of natural underground clay dykes at their lower ends that are effectual dams and clay bottoms impervious to water. Throughout many years, these beneficently provided reservoirs have supplied an enormous amount of water for pumping and since 1904 there has been a progressive drop in the water plane.

Los Angeles county's geological history ascribes these reservoirs to a fortunate condition in sedimentary land-making. An upheaval that brought the mountains at the north of the county into existence, is indicated. There is some belief that in unrecorded geological ages these mountains subsided and rose several times. Erosion carried earth and rocks from them toward the ocean, thus building up the Los Angeles plain and perhaps an upthrust along the plain's coastline aided this. Pressure upthrusts or faultline formation resulted in extensive dyke systems throughout this plain hedging in strata of gravel, boulders, sand and the like capable of enormous water storage so that these reservoirs or storage places underlie practically the entire plain.

Infiltration Areas.—It has been found that 2,500,000 or more gallons of water can be absorbed daily through every acre on which the flood water brought down by the rivers can be spread.

A natural dyke across the narrows of the San Gabriel River at El Monte makes all the flood water from the mouth of the canyon to El Monte, about ten miles, available for infiltration to the extent of 3,000 acres or more.

Approximately 2,000 acres contiguous to the Tujunga River are considered appropriate by Mr. Eaton as a spreading area, and about 1,500 acres at the San Antonio River. He estimates a total of about 9,000 acres in the county for such purpose.

Water Resources of Colorado River

The water resources of the Colorado River and its tributaries constitute the most valuable asset of a large part of the West and Southwest. With a view to determining the location, magnitude, and value of these resources, the Interior Department, through the Geological Survey, has for many years been carrying on investigations within the drainage basin of the river. Publications dealing with different parts of the basin have been issued from time to time, and the latest is Water-Supply Paper 617, entitled "Upper Colorado River and Its Utilization," by Robert Follansbee, which has just appeared. This paper, an elaborate report of nearly 400 pages which may be obtained from the Superintendent of Documents, Government Printing Office, for 65 ct., embraces the part of the drainage basin above the Green River.

The drainage area of this part of the basin is 26,500 square miles, which is 1 per cent of that above Lees Ferry, Ariz., the point that makes the dividing line between the upper and lower basins as defined by the "Colorado River compact," and the mean annual run-off is 6,600,000 acre-feet, or 45 per cent of that at Lees Ferry.

The report shows that in the area described about 564,000 acres is irrigated at present and that within possibly the next 50 years this area may be increased to 1,230,000 acres. The irrigation of the additional land will reduce the mean annual run-off by about 1,000,000 acre-feet.

The developed water power in this area amounts to 47,352 hp., divided between 41 plants. A historical sketch of this development discloses the fact that the first hydroelectric plant in the United States to transmit alternating current at high voltage for the purpose of operating a motor at a considerable distance is within this part of the Colorado River basin. This is the famous Ames plant, near Telluride, built about 1890. Another plant built about 1888 in this area was apparently the first in the world to operate an electric hoist for mining.

At 40 sites in the part of the basin above the Green River undeveloped power amounting to 117,000 hp. for 90 per cent of the time or 222,000 hp. for 50 per cent of the time has been considered. By the construction of storage reservoirs these totals would be increased to about 300,000 and 400,000 hp., respectively.

Transmountain diversions of water out of this part of the Colorado River basin now amount to 20,000 acre-feet annually, which may be increased to 300,000 acre-feet if additional projects described in the report are developed.

Wisconsin Water Supply Code Revised.—The Wisconsin public water supplies, sewerage and refuse disposal code has been revised to bring it up to date and incorporate new legislation and regulation. Tabulations are given in the code to show that 282 Wisconsin municipalities have public water supplies, excluding twelve supplies for fire protection only, and that 211 have public sewerage. There are ten municipalities with less than 500 population that have both water works and sewerage, and twenty-nine with water works only, while over one-half of the municipalities between 1,000 and 1,500 population have both, and one-fourth only water works. Two hundred eleven municipalities are equipped with public, and nine with semi-public sewerage systems, 127 of which are not provided with any form of sewage treatment to prevent stream pollution, the board reports.

Natural Purification in Polluted Waters

In the study of the pollution of streams the United States Public Health Service has directed considerable attention to the operation of natural processes in the purification of polluted water, especially the agencies and methods utilized by Nature in this process. In this intensive study it has been found that pollution (sewage, non-poisonous industrial wastes, and similar polluting matter) when put into water, is immediately attacked by bacteria which are so small that at least two millions of them could rest comfortably, side by side, on the head of a common pin. These minute organisms find the pollutional material a satisfactory food and increase rapidly in numbers. By this feeding process, oxygen dissolved in the water is used up and the pollution is transformed into harmless bacterial bodies and by-products which are not putrescible.

At first it was believed that the bacteria, unassisted, could completely purify polluted water. This was found not to be the case, however. The bacteria multiply in the polluted water until a certain number of population is reached, the limiting number varying with the amount of pollution present. When the limiting population is reached, multiplication stops and the process of purification also stops, although considerable amounts of pollution may still be present. If the bacterial population of the water is reduced at this time, the multiplification and purification processes continue. To arrange for a continuous reduction of bacterial numbers, Nature, in her marvelous economic system, has provided some very small animals, called Protozoa, whose principal food appears to be bacteria. These bacteria-eaters, which are very much larger than bacteria, but yet so small that fifty of average size could lie on the head of a common pin, feed continuously on the bacteria and thereby prevent the bacterial population from ever reaching a limiting number.

In this manner Nature provides for the completion of the purification process, and the bacteria and the protozoa in the water decrease in numbers as the amount of food available for each decreases.

The addition of any poisonous substance to the polluted water may slow up or, if a sufficient amount be added, completely stop Nature's purification process, by killing off prematurely these industrious workmen.

A series of interesting papers describing the methods employed and the results obtained in these studies are being published in the Public Health Reports under the general heading of "Experimental Studies of Natural Purification in Polluted Waters."

ADVERTISING PAGES REMOVED

Bleaching Powder as an Auxiliary Treatment of Sewage*

Experiences with Bleaching Powder (Chlorinated Lime) as an Adjunct to the Activated Sludge Process at a Sewage Disposal Plant in England

By HERBERT D. BELL

Manager and Chemist, Sewage Works, Barnsley, England

IN introductory passages the author calls attention to the fact that he had applied bleaching powder as early as 1911 for odor control ahead of the sprinkling filters at Stratford-on-Avon, England, and that the process has continued in successful operation for the past 18 years. As early as 1914, while still in charge of that plant, all of the bleaching powder was applied to the crude sewage ahead of the settling tanks, such practice having proven by experience to be a more economical and effective odor control measure than was secured by applications to the tank effluent which was more septic than the crude sewage.

Bleaching Powder as an Adjunct to the Activated Sludge Process.—The Barnsley plant consists of two detritus tanks, two Dortmund type primary settling tanks and an aeration tank of 18 channels (Haworth method of bio-aeration) which provide a three-quarter mile travel of sewage. Agitation is supplied by 18 skeleton paddles. There are two final settling tanks of the Dortmund type. The plant, completed in December, 1924, had a designed capacity of 500,000 gal. per day (D.W.F.).

The sewage received at the works is mainly of domestic origin with some slaughterhouse wastes. During dry, warm weather the sewage is almost continuously septic upon arrival at the works and under these conditions heretofore the plant could only handle about 430,000 gal. per day, the remainder being pumped, at considerable expense, to a sprinkling filter plant for treatment.

In an endeavor to partially reduce the strength of the sewage delivered to the bio-aeration units during summer, "alumino-ferric" has been applied to the crude sewage to secure chemical precipitation in the primary settling tanks. Even with coagulant dosages varying between 3.5 and 6.0 grains per gallon pumping of sewage away from the plant had to be resorted to frequently.

The summer of 1929 was a particularly trying one in view of the increased strength of sewage caused by curtailment of water consumption in the town. In consequence of past experiences with bleaching powder at the Stratford-on-Avon plant, and thus appreciating its power to restrict septic action, it was decided to try the application of this chlorine compound to the crude sewage in place of the "alumino-ferric." It was also hoped that bleaching powder would check the tendencies toward putrefaction in the bio-aeration tanks and final settling tanks. Further than this, the satisfactory use of bleaching powder ahead of trickling filters suggested that not alone would its use probably reduce the plant loading, but it might assist the aerobic organisms and thus aid in increasing purification. Bleaching powder treatment was therefore commenced April 8, 1929.

The dosage applied to the crude sewage during the first 21 days corresponded to an average of 3.15 p.p.m. available chlorine (roughly 9.5 p.p.m. of bleaching powder). The results obtained from the beginning were distinctly encouraging. During the 21-day period no crude sewage had to be pumped away from the plant, no final effluent had failed to remain stable, and nitrate nitrogen appeared in the effluent. On the other hand, during the 36-day period prior to the use of the bleaching powder twelve average effluent samples had failed to remain non-putrefactive and there was no nitrate nitrogen present in the effluent during this period. In addition there had been 84 hours of pumping to reduce the sewage delivered to the bio-aeration units.

As a result of such encouraging performance the plant was equipped with more permanent apparatus for continuous feeding of bleaching powder solution to the crude sewage. The solutions were prepared from the plant effluent which absorbed some available chlorine. The available chlorine dosages will hereafter be referred to as calculated dosages which, because of chlorine losses through absorption by the organic matter in the effluent and in the form of spent sludge from the bleaching powder tanks, is obviously higher than was actually applied to the sewage.

For regulating the bleaching powder dosage the day was divided into four-hour periods. Each period was allotted a predetermined quantity of bleaching powder solution for application. The dosage was further varied to meet conditions, i. e., increased on days of high temperatures and absence of rain and reduced when these conditions improved. In arranging the dosages of bleaching powder it was later observed that economy and efficiency resulted if the additions were made in proportion to the strength of the sewage as well as the volume of flow. The calculated dosages of available chlorine employed during each 28-day period are shown in Table I.

Normally the Barnsley plant operates on the "fill and draw" principle. The results with bleaching powder having been so encouraging an attempt was made to operate on the "continuous flow" principle. The results were not as satisfactory, however, and the "fill and draw" process was resumed. In this the sludge in the final settling tanks is withdrawn completely five or six times each day.

It was decided that application of bleaching powder to that portion of humus (activated sludge) returned to the bio-aeration units might be reasonably expected to improve conditions further and also assist in the work being done by that applied to the crude sewage ahead of the primary settling tanks. During the discharge of the sludge from the final tanks the bleaching powder solution was added and this "fortifying" of the returned sludge was found very useful. The quantities of chlorine applied, calculated on the basis of the volume of returned sludge treat-

Table I. Sewage Volumes Treated and Chlorine Dosages Applied at the Barnsley Sewage Works, April 8-August 18, 1929

Period Ending	Gal. Sewage Treated	P.P.M. Available Chlorine Added		
		Crude Sewage	Humus	Whole*
April 28	9,076,000	3.94	0	3.94
May 26	13,071,000	3.54	0	3.54
June 23	12,058,000	9.74	18.23	10.36
July 21	12,544,000	12.94	16.86	14.29
August 18	13,704,000	9.64	29.17	11.69
Average		8.17	22.09	9.04*

*Note:—Calculated dosages arrived at from "whole treatment" is based on total volume of sewage treated and the total pounds of chlorine applied to the crude sewage and the returned sludge.

*Read before The (British) Association of Managers of Sewage Disposal Works, Nov. 21, 1929, and herewith presented in abstract form.

ed, are shown in the fourth column of Table I.

During the period Aug. 1-6 showery and cooler weather allowed the discontinuance of crude sewage chlorination, but it was found necessary to continue the applications to the sludge returned from the final tanks.

During the period of chlorination (April 8-Aug. 18) only three out of 105 samples of final effluent failed to remain non-putrefactive (stable). In one instance the unstable samples were caused by an unexpected increase of flow of strong sewage and were corrected by increasing the bleaching powder dosage. No pumping to reduce the flow was resorted to as would have been required under conditions of past summers and this represented the second instance of the power of bleaching powder to bring about a recovery of the bio-aeration process without reducing the flow of sewage handled.

In view of the fact that pumping sewage away from the plant to reduce the load constitutes an added operating expense at Barnsley, the over-all operating cost during the period of bleaching powder treatment in 1929 has proven to be less than that for the same period in 1928 when "aluminoferric" was being used and pumping resorted to when necessary.

In addition to the effects noted in conjunction with the bio-aeration process it was evident from the appearance of the sewage after addition of the bleaching powder that precipitation of certain solids was taking place in the primary tanks. It was therefore evident that the bleaching powder acted in a dual capacity.

The subsequent effect of the treatment on the detritus and primary tank sludges was marked, in that the primary sludge drained more rapidly than in previous years, and without odors being produced. The detritus sludge drained more rapidly, and with less odor than previously.

The Use of Bleaching Powder on Percolating Filters.—In an attempt to control the filter flies (Psychoda) at the trickling filter plant, bleaching powder solution was applied once weekly to the settled sewage. Monday mornings were selected as being the time during which the sewage received was the weakest and therefore the most appropriate time for the treatment.

Experimentation indicated that the most effective and economical dosage of bleaching powder was that which after a 20 minute period of contact insured the presence of residual chlorine in the applied sewage as it trickled over the stone beds. The bleaching powder was made into an emulsion in a barrel, the contents then being discharged at once to the sewage en route to the distributors on the filters. (The Barnsley percolating filters are circular and equipped with revolving distributors. There are no siphon tanks such as are employed with sprinkling fiters of American design.) The quantity of bleaching powder which produced the best results in connection with the Barnsley sewage was in the proportion of 15 lb. to each 100 ft. diameter unit, equivalent to approximately 85 lb. per acre. The weekly application to each unit resulted in a very much reduced fly population around the plant.

At the same time the numbers of the psychoda destroying springtail (Achorutus Viaticus) were apparently greater than in former years and the filter surfaces are all very clean.

Engineers Plan National Activity in Public Affairs During 1930

Selection of administrative officers to carry out plans for national activity in public affairs during 1930 are announced by the American Engineering Council. Major Gardner S. Williams of Ann Arbor, Mich., has been named acting president of the Council.

He will occupy the office until the return from a trip around the world of Carl E. Grunsky of San Francisco, former head of the American Society of Civil Engineers, who has been elected president for a two-year term, succeeding Arthur W. Berresford of New York.

Major Williams has been identified with the Council since its organization as the public service body of the engineering profession ten years ago under the headship of Herbert Hoover. Major Williams, a former professor in the University of Michigan, is a vice-president of the Council, and is chairman of its Committees on Government Reorganization and Flood Control. He is the representative on the Council of the Detroit Engineering Society, one of thirty national and local engineering organizations of which the Council is composed.

Following are the new members of the Administrative Board, the governing body of the Council, together with the constituent societies having a membership of 58,500 professional engineers which they represent:

American Institute of Electrical Engineers—C. O. Bickelhaupt, Atlanta, Ga.; H. A. Kidder, New York City; R. F. Schuchardt, Chicago; Prof. C. F. Scott, Yale University; C. Skinner, East Pittsburgh.

American Society of Civil Engineers—H. S. Crocker, Denver, Colo.; A. J. Dyer, Nashville, Tenn.; Anson Marston, Iowa State College; Frank M. Williams, Albany, N. Y.

American Society of Mechanical Engineers—Charles Piez, Chicago; John Lyle Harrington, Kansas City, Mo.; R. C. Marshall, Jr., Chicago; E. N. Trump, Syracuse, N. Y.; John H. Lawrence, New York City; D. Robert Yarnall, Philadelphia.

American Institute of Chemical Engineers—Dr. Harrison E. Howe, Washington.

American Institute of Consulting Engineers—Edwin F. Wendt, Washington

American Society of Agricultural Engineers—Prof. William Boss, University of Minnesota.

Regional district members of the Board follow:

District No. 1, George A. Reed, Commissioner of Public Works, Montpelier, Vt., representing the Vermont Society of Engineers; District No. 2, Burritt A. Parks, Grand Rapids, Mich., Grand Rapids Engineers Club; District No. 3, J. S. Dodds, Ames, Ia., Iowa Engineering Society; District No. 4, C. B. Hawley, Washington, D. C., Washington Society of Engineers; District No. 5, A. A. Krieger, Louisville, Ky., Engineers and Architects Club of Louisville; District No. 6, W. W. Horner, St. Louis, Mo., Engineers Club of St. Louis.

1929 Meeting of New Jersey Sewage Works Association

The 15th annual meeting of the New Jersey Sewage Works Association will be held March 21 and 22 at the Hildebrecht Hotel, Trenton, N. J. The program includes the following:

Papers on Operating Experience by F. M. Veatch, Kansas City Mo.; Chas. Hommon, Canton, O.; Chas. Capen, Orange, N. J.; A. W. Dare, Bridgeton, N. J.

Drying Sludge Under Glass—Floyde G. Browne, Marion, O.

Drying Green Sludge for Fertilizer—Chester G. Wigley, Atlantic City.

Mosquito and Sewage Disposal—Ginsberg and Forman. Control of Breeding in Disposal Works—Lester Smith. Control of Breeding in Cesspools.

The New Plant at Red Bank—H. Burdett Cleveland, New York.

Experience with Activated Sludge—Maj. M. Blew, Philadelphia.

The Biology of Sewage Disposal—Dr. Houkalekien, New Brunswick, N. J.

Round Table Discussions—Odor Control, Operator Problems, Standard Greenhouse Construction, Suitable Paints, Suitable Pipe Construction, Sludge Drying.

J. R. Downes, Bound Brook, N. J., is secretary of the association.

Water Softening Plants in Ohio.—Four villages and one city installed water softening plants during 1929, making a total of 26 municipal plants in service in Ohio. The new plants are Crooksville, Gallipolis, Glouster, Marysville and St. Clairsville. The villages of Granville, New Bremen and Woodville have plants nearing completion which will be placed in operation shortly. Six of the eight new plants soften well water. Many other municipalities in Ohio are considering water softening.

The First Filter.—The first filter for a public water supply is stated to have been built in 1929 by James Simpson, engineer of the Chelsea Water Co., London, Eng. This filter merely served as a mechanical strainer for removing the turbidity from the water. It is reported to be still in service.

Gas Production from Imhoff Tanks

Results of Tests Conducted at an Experimental Sewage Tests Plant at the University of Illinois, Urbana, Ill.

A SERIES of tests conducted recently at the Engineering Experiment Station of the University of Illinois has brought out some interesting information on sewage treatment, particularly as relating to Imhoff tanks. The tests, which were made at an experimental plant at the station, were begun in June, 1925, and continued until June, 1929. They were made under the supervision of Harold E. Babbitt, Professor of Sanitary Engineering at the University. The results are set forth by Prof. Babbitt and Harry E. Schleng, Research Graduate Assistant in Civil Engineering, in a bulletin issued recently by the Engineering Experiment Station. The following notes on gas production are taken from the bulletin.

Tests were conducted on the Imhoff tank, for the purpose of determining the quality and quantity of gas produced in an Imhoff tank.

The tests on the factors governing the production of gas in an Imhoff tank were divided into two parts; one in which the temperature of the sludge-digestion chamber of the tank was not calculated from the sludge level in the tank, which was determined weekly. In the first part of the tests the temperature of the sludge-digestion compartment was determined semi-weekly. When the heating system was put into operation, the temperatures at five different depths in the tank were taken by means of bottles filled with clear water. These bottles were suspended at different points along a chain and were drawn to the surface for readings. The temperature of each bottle was taken three times a day to assure the proper temperature control of the heating unit. The hydrogen-ion concentration of the sludge in the tank was determined weekly.

Results of Tests.—Average values for the gas production, the temperature of the sludge compartment, the hydrogen-ion concentration, and the volume of sludge in the tank during the first part of the test in which the temperature was not controlled are shown graphically in Fig. 2. The observation of the rate of building up of sludge in tank was made possible because only a small amount of sludge was used for seeding. This rate is shown graphically in Fig. 2. The relation between the amount of gas produced and the volume of sludge in the sludge compartment is well demonstrated because other conditions such as hydrogen-ion concentration and temperature of the sludge compartment were approximately constant during this period.

The average flow of gas for the entire period of the test was 46.6 cu. ft. per 24 hours, or, on a basis of a flow of sewage of 19,500 gal. per day, it was 2,380 cu. ft. per million gallons of sewage. According to the figures of the Sanitary District of Champaign and Urbana, the average sewage flow is 3,500,000 gal. per day, computed on a yearly flow basis. The population of the city of Champaign is 24,000 and that of Urbana is 14,000. The student body of the University of Illinois of 10,000 is in attendance but nine months of the year, making a tributary population of 7,500 persons on a yearly basis. The total tributary population is, therefore, equivalent to 45,500, making a yearly average of about 80 gal. of sewage per capita per day. Using this figure the average flow of gas would be 0.298 cu. ft. per capita per day. Dr. Karl Imhoff obtained the figure of 0.3 cu. ft. per capita per day as the average gas production from Imhoff tanks in the Emscher District in Germany from an ordinary domestic sewage.

After the installation of the hot-water circulating system for controlling the temperature of the sludge-digestion compartment, it was possible to obtain slightly higher temperatures that were obtained in the previous period. However, it was found that the maximum temperature that could be obtained in the sludge chamber with the heating apparatus on hand was about 24° C. This was due to the constant cooling effect of the sewage passing through the tank.

The temperature of the sludge compartment was gradually increased to the maximum value possible with the apparatus on hand, and then allowed to fall. The relation between the amount of gas produced and the temperature of the sludge-digestion chamber is well demonstrated because other conditions such as the volume of sludge in the tank and the hydrogen-ion concentration were approximately constant during this period.

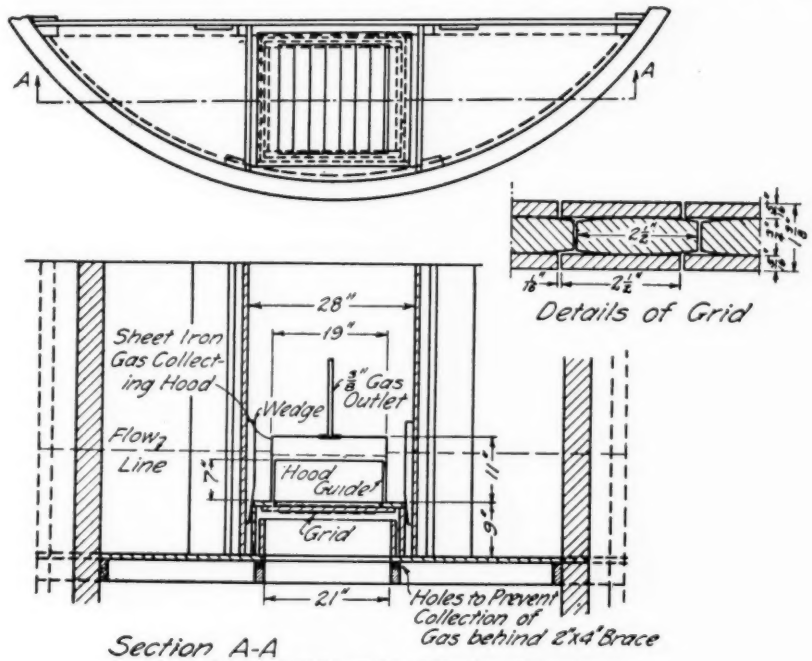


Fig. 1.—Details of Gas Collecting Apparatus.

Quality of Gas Produced.—Analyses of the gas produced were made occasionally, an Illinois gas apparatus being used. The results of the gas analyses obtained in these tests are given in Table I.

The presence of oxygen is believed to be due to air contamination of the samples.

Conclusions.—From the results of tests on the production of gas in an Imhoff tank the following facts have been demonstrated:

(1) The amount of gas produced in an Imhoff tank increases with an increase in the amount of sludge accumulating in the tank, this fact being especially noticeable when the tank is first seeded (see Fig. 1).

(2) The temperature of the sludge-digestion chamber has a marked effect upon the gas production, the gas production increasing with an increase in

Table I.—Analyses of Imhoff Tank Gas.

Date	Source	Composition in Per Cent CO_2	O_2	H_2	CH_4	N_2
June 21, 1926	East Vent	11.8	1.2	4.6	70.20	12.20
	West Vent	9.6	1.0	0.0	66.15	23.25
February 7, 1927	East Vent	15.3	0.4	1.3	63.30	3.70
February 24, 1927	East Vent	10.8	2.6	1.2	61.10	13.90
April 6, 1927	East Vent	4.5	0.9	2.0	73.70	15.30
Average		10.4	0.8	1.8	66.89	13.67

temperature. It was not possible to obtain temperatures higher than 24° C. with the apparatus on hand, so that the upper limit of this relationship could not be determined.

(3) The grids placed under the gas collecting hoods are quite effective in preventing the formation of a heavy scum at this point. This is probably due to the fact that the grids are submerged, which causes the scum to remain moist while its gas is being liberated. After the gas has been liberated the material gradually sinks to the bottom of the tank.

(4) The average quantity of gas obtained from the Champaign sewage, an ordinary domestic sewage, was about 0.3 cu. ft. per capita per day. This amount of gas would not appear to be sufficient to warrant its collection and distribution as a public gas supply. It might be feasible to utilize the gas for fuel purposes about a sewage treatment plant, and to aid in keeping the temperature of the tanks at least up to the temperature of the incoming sewage in the colder months.

(5) It is not practicable to heat the sludge-digestion chamber of an Imhoff tank above the temperature of the incoming sewage for the following reasons:

(a) The amount of heat lost by the flow of sewage through the tank is so great as to prevent the heating of the sludge chamber beyond a certain temperature depending upon the temperature of the incoming sewage. With the type of heating unit used it was not possible to raise the temperature of the sludge-digestion chamber above 24° C., while the temperature of the effluent from the tank was, on the average, 10° C. higher than the influent. Since the average flow through the tank was 13.5 gal. per minute, this would mean a loss of 2,020 B.t.u. per minute or 149,000,000 B.t.u. per million gallons of sewage from this source alone.

(b) In order to offset the loss of heat due to the passage of the sewage through the tank, the temperature of the heating coils would be so great as to cause the sludge in close proximity to be heated excessively, and thereby digestion might be inhibited.

(c) When the sludge digestion chamber is heated above the temperature of the sewage in the flowing-through chamber convection currents are set up through the slot with resulting disturbance of sedimentation.

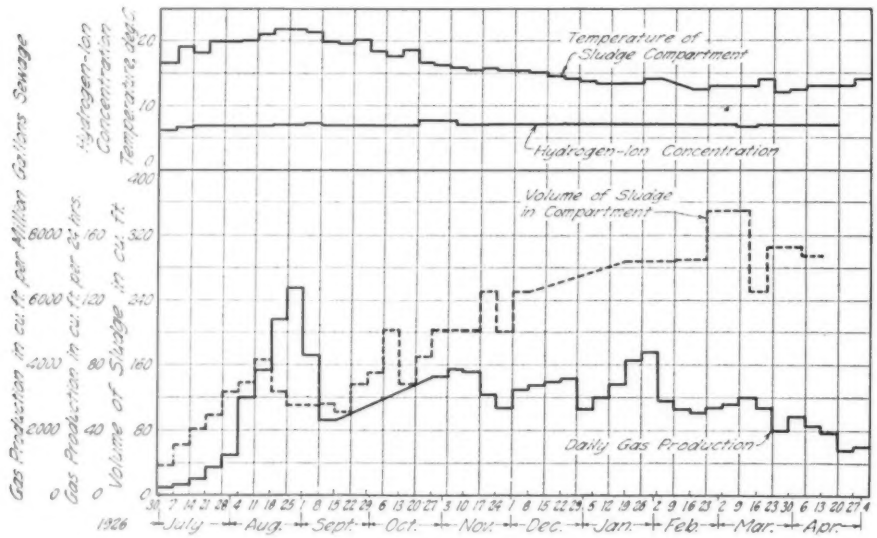


Fig. 2.—Weekly Averages of Imhoff Tank Gas Production.

Cost of Engineering, Large Dam and Reservoir

Figures on the cost of engineering on the O'Shaughnessy dam and reservoir of the city of Columbus, Ohio, are given in a paper by John H. Gregory, C. B. Hoover and C. B. Cornell, presented before the American Society of Civil Engineers. These costs are set forth in Table I, accompanying.

It will be noticed that the percentages in this table are based upon a construction cost which covers other items than the cost of the dam and reservoir. This is because other engineering work was being designed and constructed under the supervision of the organization in charge of the design and construction of the dam at the same time that work was being carried out. In spite of the fact that each engineering assistant was required to keep a record of his time, it would have been exceedingly difficult to distribute accurately the total cost of engineering during this period to the dam and reservoir and to this other work. General expenses and the cost of supplies could not have been assigned with accuracy.

The work carried out by the department during this period, however, all consisted of some kind of water-works construction. The chief items were the enlargement of the water-purification works and the laying of additional cast-iron mains. As shown, the total cost of all this work was $3,217,440 and the cost of engineering applying thereto was $324,810, or 10.10 per cent of the total construction cost. A distribution of engineering costs is given in Table I.

The cost of the dam and reservoir per 1,000,000 gal., subdivided under cost of land, dam and reservoir, is given in Table II. The difference between the unit-cost based on available capacity and that based on total capacity is about 1 per cent. The costs in Table II do not include the cost of engineering.

Table I—Cost of Engineering, O'Shaughnessy Dam and Reservoir and Other Works

Items	Cost	Percentage based on total cost of construction of $3,217,440
Construction:		
O'Shaughnessy dam and Reservoir	$2,220,080	69.00
Enlargement of water-purification works	397,140	12.34
Cast-iron force mains	560,920	17.44
Cast-iron distribution mains	34,050	1.06
Miscellaneous	5,250	0.16
Total cost of construction	$3,217,440	100.00
Engineering:		
Borings and sub-surface investigations	$ 10,800	0.34
Pay-roll	271,280	8.43
Supplies	11,110	0.35
Expenses	31,620	0.98
Total cost of engineering	$ 324,810	10.10
Summary:		
Construction	$3,217,440	100.00
Engineering	324,810	10.10
Total cost	$3,542,250	110.10

Table II—Cost per 1,000,000 Gal., O'Shaughnessy Dam and Reservoir

Items	Total cost	Cost per 1,000,000 Gal. Total capacity, 5,400,000,000 gal.	Available capacity, 5,341,000,000 gal.
Land	$ 290,130	$ 54	$ 54
Dam	1,146,970	212	215
Reservoir	782,980	145	147
Total, exclusive of engineering	$2,220,080	$411	$416

Water Works in Kansas.—On Jan. 1, 1923, there were 261 water works in Kansas; on July 1, 1925, 264; on July 1, 1927, 283, and on Oct. 1, 1929, 308.

The Combined Operation of Water and Light Plants

An Interesting Discussion on the Advantages and Disadvantages Based on Conditions Obtaining at the Combined Plant of Kansas City, Kan.

By J. D. DONOVAN

Manager of Production and Distribution, Board of Public Utilities, Kansas City, Kan.

IN discussing the advantages and disadvantages of the combined operation of water and light plants the following observations are based primarily on a water plant deriving its source of supply from open water courses, and a light plant using in connection with steam driven prime movers, surface condensers, and they for the most part refer particularly to the writer's experience in the combined operation of the Kansas City, Kan., water and electric light plant. It is not intended to leave the impression that this set of conditions are necessary to obtain all of the advantages that can be gained from combined operation but they are mentioned on account of their direct bearing on the production department more than for any other reason.

Joint Use of Investment.—Foremost among the advantages of combined operation is the matter of investment required in certain of the physical properties such as land, buildings and warehouses, as well as the minor investment in certain forms of auxiliary apparatus together with tools and miscellaneous equipment. In the Kansas City, Kan., plant there is, for instance, an intake well located within the harbor lines of the Missouri River having a maximum capacity of approximately 100,000,000 gal. daily, this well being fitted with revolving trash screens and serving the purpose of supplying water to low pressure pumps for the settling basins of the water plant as well as for condensing purposes on the turbo generating units. Adjacent to this intake well is the low pressure pumping station having a total installed pumping capacity in motor-driven centrifugal units of some 90,000,000 gal. per day. Both of these investments are jointly used by the water and electric plant and, except for the installed capacity of pumping equipment, would amount to substantially the same total investment were either plant to be operated separately; hence a substantial saving in fixed charges to both plants is affected through this combination.

From this low pressure pumping station located on the river to the settling basins there are constructed two discharge mains that pass first through the turbo generating room and thence to the settling basins and they are so placed and inter-connected that either main can be used on any one of five turbo-generating units with the final discharge of water being made in the settling basins or wasted back to the river as load conditions may require. This flexibility of piping arrangement would, of course, be unnecessary were water delivered from the low service pumping station to the settling basins for water department use only, but inasmuch as the investment necessary for this flexibility is provided by the electric plant and the major portion would have to be provided whether operated in conjunction with the water plant or otherwise, this piping arrangement does not in any way affect the ultimate investment of the water plant. Of course some additional head is encountered because of increased friction in pumping water from the river through the more circuituous route required to serve the electric plant, and a further additional head of approximately 10 ft. is encountered through the normal friction of the surface condensers, but this difference in pumping head is absorbed by the electric plant in the proration of pumping costs between the two departments and hence does not effect any increase to the water plant.

Requirements for Condensing Purposes.—The advantages of this arrangement are limited to the balance of requirement for water in the settling basins of the water plant as compared with the requirement of water for condensing purposes in the electric plant; i. e., up to a point where the water required by the electric plant for condenser purposes does not exceed the amount required by the water plant for its particular function, the maximum of economy through this arrangement is obtained. After this point is reached, however, and the requirement for condensing water in the electric plant exceed the requirements of the water plant for water, the advantages, of course, commence to disappear and would eventually be lost altogether when the difference in water requirements of the two plants becomes great enough, because it is obvious that it would be expensive to pump excessive quantities of water at the higher head occuring through combined operation. However, when this point is reached, it is possible to still retain the major portion of these economies by interconnecting certain of the turbo-generating units in such a manner that only such capacities will be served in combined operation as will be justified by the water requirements of the water plant, the balance to be served through lower heads in connection with tailing pipes for river return.

In the design of condenser equipment at the Kansas City, Kan., electric plant we are required to specify a maximum water temperature existing in the Missouri River during the summer period of 80° F. and this, together with the relatively low steam pressure and superheat of the station and their resultant effect on the steam consumption of turbo-generating units, makes it necessary to specify approximately 2 sq. ft. of condenser surface for each kilowatt of turbo-generator rating, and with this temperature of circulating water it is necessary to have approximately 0.9 gal. per minute per square foot of condenser surface, or 1.8 gal. per minute per kilowatt of turbo-generator capacity.

At the present time our normal peak load is 19,000 kw. requiring circulating water at the rate of 34,000 gal. per minute. The load factor, however, on the electric plant is such that the average requirement for condenser water represents only 58 per cent of this amount, or approximately 19,000 gal. per minute, which is slightly in excess of the present average requirement of the water plant. This means that during times of peak load on the electric plant we are now forced to waste a certain per cent of circulating water back to the river which, of course, is the portion not required by the water plant, and this waste is of water which has been pumped at a head much higher than would be required for the electric plant only; hence this advantage of combined operation is commencing to decline in our plant because of the more rapid growth of the electric plant than that of the water plant. In order to maintain the greatest degree of economy in this feature through combined operation, it is proposed in the near future to isolate certain turbo-generating units and to provide separate pressure heads on the low service water pumping system.

I do not mean to leave the impression from the foregoing that this condition of operation has reached a point of wastefulness as yet, because the figures previously set out cover circulating water requirements under con-

ditions of high river water temperature and since, of course, the peak loads on the electric plant and water plant are not coincident, the waste of water during periods of peak load in the electric plant occurring during the fall and winter months, is not so very great because of the lower temperature of the river water during this period. In the warm period of the year the load on the electric plant is relatively lower and the volume of water required by the water plant is considerably greater, which permits the average result to still be entirely satisfactory.

The passing of this low pressure water through surface condensers gives an advantage to a water plant using open settling basins during the winter season of the year, due to the fact that the temperature of the water is increased enough to prevent the formation of ice on the settling basins, and this increase in temperature aids materially in the reaction of applied chemicals used for settling and treating purposes, but of course during the warmer periods of the year it appears as a disadvantage due to raising the temperature of the distributed water to a point higher than that of the river water, the ordinary rise over the condensers being between 10° and 15° F.

Electrically-Driven Pumping Equipment.—Combined operation of water and electric plants permits the economical use of a considerable amount of electrically-driven pumping equipment that would not prevail in a separately operated water plant. In Kansas City, Kan., the high pressure pumping equipment consists of two 12,500,000-gal. cross-compound, condensing, crank and flywheel type pumping engines and one 25,000,000-gal. two-stage synchronous motor-driven centrifugal pumping unit, and in the pumping of high pressure water by these units we again have the advantage of joint investment. This particular division of the water plant proper is operated on a customer basis with the electric plant; i. e., the electric plant furnishes to the water plant either steam for the operation of the high pressure steam pumping equipment or electric energy for the operation of the motor-driven high pressure equipment. Certain investments held jointly by the two departments are taken into consideration when fixing the rates charged for either steam or electricity to the water plant. The boiler plant building, for instance, houses equipment owned jointly by the two plants, by far the larger portion of which belongs to the electric plant, and this of course is served by a common set of coal and ash handling equipment and other auxiliary apparatus. Likewise, the main engine room houses high pressure pumping equipment as well as turbo-generating equipment and is served jointly by the same crane and other common facilities, and it is of course evident that if either plant were operated separately they would be required to support individually, though in a smaller way of course, these points of common investment, which would naturally reflect some increase in their fixed operating expense.

In the Kansas City, Kan., plant the 25,000,000-gal. motor-driven unit is operated as much of the time as possible. The reason for operating this unit continuously of course would not be parallel to what may be found in other pumping stations, but to us it means a substantial saving in operating expenses through the saving of packing, pump valves, lubricating oils and other miscellaneous materials used in the operation of crank and flywheel type of pumping units. Of course the present development in steam turbine-driven centrifugal pumping units would not offer by any means the same comparisons of economy as prevail in the Kansas City, Kan., station, but on the other hand where the size of the prime movers in the electric plant are sufficiently large to permit design having low steam consumption per kilowatt-hour, the ultimate duty obtained from a motor-driven unit is substantially the same as can be obtained from a steam turbine-driven unit of the same size and under the same conditions. The motor used on this centrifugal pump has been especially designed for power factor correction, and it is this feature in its continuous operation with the electric plant that enables the furnishing of electric energy to the water plant at a low rate because the electric plant benefits very materially through the operation of this motor in power factor correction on the station bus bars.

It is possible to operate in this manner without violating any requirements or suffering any penalties from the National Board of Fire Underwriters because the boiler plant is always under pressure serving the steam requirements of the electric plant and should electrical outage occur, the steam pumping equipment is ready to move on a moment's notice from steam supplied through the same source; hence continuous operation of the electrically-driven water pumping equipment is not burdened with any standby boiler expense, the only cost to the water department when operating with steam being that which they are charged on a per 1,000 lb. basis. The electric plant profits materially through this continuous operation of electrically-driven water pumping equipment to the extent that excitation losses on the turbo-generating units are reduced to a minimum and machine capacity is maintained at a maximum with of course decidedly improved regulation.

Effect on Personnel.—Another point of advantage in the combined operation of water and electric plants of course would apply generally to all combined installations, and that is the matter of superintendence, operation and maintenance of the equipment of both plants. For instance, in Kansas City, Kan., there is but one chief engineer of the power station who has complete supervision over both the water and electric plants and there is also one operating engineer on each shift who in turn supervises the operation of both plants during his time on duty. In the remaining members of the routine operating crews many instances occur where employees such as firemen, helpers, coal men, oilers, etc., divide their time between both plants, thus aiding materially in the reduction of operating costs.

In the matter of maintenance, the advantage of joint operation is again reflected in the fact that the same mechanics repair and maintain equipment of both plants, and while it is true that the combined operation requires possibly a somewhat larger number of men, it is also true that were the plants to be separated it would not be possible to diminish the crews by one-half, and it is Kansas City, Kan., experience that joint maintenance reflects very substantial savings to both plants in this respect.

Joint operation also permits the retention of a better class of technical employees such as engineers, draftsmen, etc., without excessive expense to either plant, thereby increasing operating efficiency of both plants and facilitating the careful planning of any needed additions or betterments to either plant as well as insuring the preparation and keeping of accurate maps and many statistical records concerning the extension and operations of both plants.

Owing to the wide diversity in the character of the work performed in the distribution of water and electricity throughout the city, it is not possible to effect any great economies through combined operation, although there are of course some few points of common interest involving the use particularly of unskilled labor that permits these departments to function somewhat more efficiently than were they controlled and operated by separate maintenance organizations. There is considerable advantage in the operation and maintenance of a common warehouse and store yard at which point materials are received and disbursed for the use of either the water plant or the electric plant. The store yard is supervised and operated by a single crew and were the two plants to be separated it is doubtful if over one-third of the help could be dispensed with, because so much of the work involved is routine and the excess is only measurable in the increased quantities of material to be handled through joint operation.

Effect on Major Administration Features.—A material saving is effected through joint operation of water and

electric plants in the major administration features as well as the billing and accounting departments. For instance, in Kansas City, Kan., there is one manager of production and distribution who is responsible for the production and distribution of both the water and electric plants. There is also one manager of collection and accounts responsible for the collection and accounting features of both plants; and while the state law very properly provides that separate sets of books and accounts must be maintained for both the water and electric departments, this does not mean that it is necessary to have a duplication of accountants, hence in Kansas City, Kan., one auditor supervises both sets of books, one cashier the collections of both departments, and one chief clerk the supervision of the billing of both departments, and were the plants to be separated it is obvious that practically all of these positions would be filled for each plant separately.

In the matter of reading of meters there is further economy due to the fact that a great percentage of our customers have both water and electric service and the meter readers are required to read both water and light meters; and while of course it may take somewhat longer to read two meters on the premises of one customer, it certainly doesn't take twice as long, consequently a substantial saving is made in this respect. These same general comments follow through the service and trouble departments where further duplication of employees is avoided through combined operation.

Water and Electric Rates and Costs.—Water rates in Kansas City, Kan., range from 25 ct. per 100 cu. ft., with a $1 minimum for the small user, to as low as 6 ct. per 100 cu. ft. for consumers using more than 400,000 cu. ft. of water per month, and considering the fact that these rates cover the treatment, filtration and distribution of the very difficult water encountered in the Missouri River, they are, all things considered, extremely low.

In the electric plant the average paid by all domestic customers during the past year was 3.8 ct. per kilowatt-hour, the average rate paid by all commercial customers was 3.7 ct. per kilowatt-hour, and the average rate paid by industrial power users was slightly over 1 ct. per kilowatt-hour, although several of these larger users have earned rates for the year substantially under 1 ct. per kilowatt-hour.

The average cost of pumping and distributing water for the year was 11 ct. per 1,000 gal., this figure including interest on outstanding bonds as well as depreciation at the rate of 2¾ per cent on the book value of the property. The cost of producing and distributing electric energy during the past year has averaged approximately 1.5 ct. per kilowatt-hour, although during the last six months it has fallen to as low as 1.3 ct. per kilowatt-hour; due principally to lower cost of fuel; and these production costs cover all items of expense, including interest on outstanding bonds as well as depreciation at an amount equal to 6 per cent of the book value of the entire property.

The purpose of the foregoing figures is to furnish some tangible evidence of economy resulting from the combined operation of the Kansas City, Kan., water and light plant and it has been conservatively estimated that were these two plants to be separated and operated under the prevailing conditions of load and equipment by separate operating organizations, the cost of producing and distributing electric energy would be increased by not less than 25 per cent, while the cost of pumping and distributing water would be increased by as much as 40 per cent.

It is not the writer's contention that these few remarks cover all the advantages to be gained through joint operation of water and electric plants, nor is it contended that all the points that have been mentioned are applicable to every plant, but generally speaking, it must be evident from the foregoing that many advantages of economical operation accrue through the joint operation of such utilities, and unless there are some extraordinary limiting physical conditions in a particular plant, these advantages greatly outweigh any disadvantages that may arise through such operation.

Acknowledgment.—The above is a paper presented Feb. 13 at the 8th annual Three Day School at the University of Kansas and the 5th annual meeting of the Kansas Water Works Association.

Rainfall in the 1927 New England Flood

When the New England Flood of November, 1927, occurred, says a statement from the Geological Survey, it resulted from the fact that a tropical storm moving up the Atlantic coast entered New England and was met by two high-pressure areas, one coming from the northeast and one from the northwest. The tropical storm was caught between the two cold areas of high pressure and was forced to pass over them, causing torrential rainfall. The ground had been thoroughly saturated by heavy rains during October, and natural storage capacity had been filled. Consequently the rivers quickly overflowed their banks, causing the most severe flood of which we have knowledge over extensive areas in New England.

A report just issued by the Department of the Interior as Water Supply Paper 636-C, by H. B. Kinnison, a hydraulic engineer of the Geological Survey, describes the unusual meteorologic conditions that caused the storm and presents extensive tables of rainfall for stations in the New England States, New York, and Canada. Maximum discharge and rates of discharge for 134 points on streams in the flooded area were determined. The highest recorded rainfall for the storm was at Somerset, Vt., where the total precipitation was 9.65 in. Considerably greater amounts of rain undoubtedly fell in the Green Mountains, which were not well covered by precipitation records. In general, the flood flows reached a maximum of more than 100 second-feet to the square mile of drainage area, and several determinations show 300 to 500 second-feet to the square mile. At many points the flood flow was reduced by storage in reservoirs which did not spill until the peak stages had occurred in the rivers below. An excellent example of the effect of reservoirs on flood flow is shown by the records for the Deerfield River, where storage in the Somerset and Davis Bridge Reservoirs reduced by 50 per cent the effective flood producing area of the river at Charlemont, Mass.

The total number of reported lives lost in New England was 85, one in Rhode Island and the rest in Vermont. The financial losses in Vermont were estimated at $28,000,000; the losses in highways, railroads, industries, and municipalities were about equal and each, roughly, 23 per cent of the total. The losses to railroads in New England because of the flood were almost $13,000,000, and the total loss as shown by incomplete estimates was more than $37,000,000.

Sewage Treatment Gaining in Ohio

During the last year marked progress was made in sewage treatment by cities in Ohio, according to "Ohio Health News" of Jan. 15. New modern plants were placed in operation at Alliance, Dayton, Elyria, New Lexington, Oxford and Salem. The Akron plant was placed in service during the last weeks of 1928. The seven foregoing plants are designed to serve a total population of 621,400. Toledo has awarded contracts for a plant and construction will be started shortly. Columbus is preparing plans for sewage treatment improvements.

There has been a marked improvement in operation of the smaller sewage treatment plants throughout the state. This is due to increased municipal funds for maintenance provided by sewer rental, supervision of operation of smaller plants by the superintendent of a neighboring larger plant, and the increased attention to this matter which is given by the State Department of Health. One assistant engineer spends a large portion of his time in visiting sewage treatment plants.

Decisions of the Ohio Supreme Court in the Bucyrus and Delphos cases have awakened other municipalities to the necessity of proper sewage disposal.

Aeration in Water Purification

Operating Results of Fine Spray Aeration at Several Filtration Plants

By MALCOLM PIRNIE
Consulting Engineer, New York, N. Y.

TILLMAN'S table* has made readily available the simple requirements for non-active waters. It is obvious from this table that to be non-active waters having bicarbonate alkalinities of less than 100 p.p.m. must not contain more than 2 p.p.m. of free CO_2 resulting in a pH between 8.1 and 8.3. Hence CO_2 is the chief offender in a clear filter effluent which is alkaline. Carbon dioxide is a dissolved gas found in clear waters from springs, wells, slow sand and rapid sand filters. It can be expelled by fine-spray aëration from clean waters down to a residual of from 2 to 4 p.p.m. The residual can be neutralized by adding hydrated lime at a rate of from 0.1 to 0.5 grains per gallon, resulting in a pH of 8 or over. Equivalent doses of caustic soda may be substituted for the lime whenever the addition of lime is undesirable. Such treatment may be provided at moderate cost compared with the resulting savings to all consumers of water.

Experiments on the effects of fine-spray aëration as a part of the purification process in treating various waters were begun by the author after the war. These experiments resulted in the adoption of fine-spray aëration both as a primary treatment and for expulsion of CO_2 from the filtered water at West Palm Beach, Fla., Albany, N. Y., and Providence, R. I. Fountain aëration of the settled water was installed at Watertown, N. Y. The waters treated by these plants are moderately to very soft and moderately to highly colored. Fine-spray aëration for the very turbid, soft Dan River water at Danville, Va., was provided for the water immediately after receiving the alum dose and has demonstrated its effectiveness during the last five years in producing satisfactory coagulation with much less alum and soda than was formerly required. Recent tests for a paper-mill supply from the acid waters of the upper Potomac River have shown that immediate fine-spray aëration after dosing with soda ash procedures an excellent quick-setting floc and a pH in the water equal to that produced by twice as much soda which, without aëration, yields a poor and finely-divided floc. In view of these tests and the fact that flood stages in the river carry turbidity similar to that in the Dan River, a fine-spray aërator is being designed for the dosed water before it enters the coagulation basins. The filter effluent will not be aërated, but the residual CO_2 will be completely neutralized with caustic soda.

Providence, R. I.	Color	Total Hardness	Alkalinity	CO_2	pH
Raw Water	35	5	4.2	1.7	6.0
Effluent from First Aerator	....	6	....	1.6	6.1
Alum-Treated Water	....	....	....	5.3	5.9
Settled Water	....	....	....	3.8	6.1
Filtered Water	7	....	1.2	3.6	6.1
Effluent from Second Aerator	....	....	....	2.7	6.4
Effluent After Liming	11	10	4.5	0.2	7.7

In the filter plants just mentioned, aëration has proved to be invaluable as an aid to coagulation, as a means of reducing the corrosiveness of the water and in eliminating or greatly reducing tastes and odors. Operating results of some of the filters are given below. The results, with exception of the pH, are expressed in parts per million.

Watertown, N. Y.	Paper Filtered Color	Alkalinity	CO_2	pH
Raw Water	90	32	3	6.9
Alum-Treated Water	17	13	23	5.9
Water halfway through River Basin	6	11	7	6.4
Outlet from River Basin	5	11	6	6.5
Filter Effluent	3	12	2	6.8

West Palm Beach, Fla.—Average results of operation during February, 1929.—Raw water is dosed with an average of 3.32 grains per gallon of alum; pumped to aërator; falls into coagulation basins; passes through filters; effluent controlled by aëration in fine-spray nozzles and variable nozzle; water from effluent aërator treated with 0.14 grain per gallon of lime (Table I).

Danville, Va.	Turbidity	Alkalinity	CO_2	pH
Raw Water	180	16.5	2	7.4
Treated Water Not Aerated	No Floc	13.5	7	6.6
Treated Water Aerated	Excellent Floc	14.0	2	7.2
Water Filtered Through Cotton	0	14.0	2	7.2

Table I	Color	Alkalinity	CO_2	pH
Raw Water	107	25	1.5	7.3
Alum-Treated Water	....	.....	28.0*	5.5*
Water on Top of Filters	24	3.7	5.5	6.3
Aerator Effluent	15	6.0	3.3	6.7
Water in Clear Well After Liming	14	7.4	2.4	6.9

*Result of one test; not part of routine tests.

Harder well water is used for washing filters and causes increase in alkalinity in the effluent aërator. About three times as much lime should have been added to produce pH near 8.

Providence, R. I.—Average results of operation during January, 1929.—Raw water is aërated; dosed with 0.54 grain per gallon of alum; passes through a mixer into open basins holding it about six days. Settled water passes through filters; filter effluent controlled by aëration similar to West Palm Beach; water from effluent aërator treated with 0.18 grain per gallon of lime.

In April, May and June, 1929, a pH average of 8.0 to 8.1 was obtained with 0.15 to 0.17 grain per gallon of lime.

Watertown, N. Y.—Test of operation, November 6, 1922.—Raw water dosed with 3.3 grains per gallon of alum as it enters an 8-day river basin through a mixer. Settled water aërated in a fountain and filtered.

This water needed about 0.15 grain per gallon of lime to raise its pH close to 8.

Danville, Va.—Experiment, February 12, 1923.—Raw water dosed with 0.8 grain per gallon of soda ash followed by 2.0 grains per gallon of alum. Dosed water was mixed thoroughly and half of it immediately aërated. Both portions were then allowed to stand a few minutes.

Test of Plant Operation Aug. 28, 1929.—Raw water first dosed with 1.25 grains per gallon of alum and aërated through fine-spray aërator. Effluent from the aërator filtered and tested.

Danville, Va.	Turbidity	Alkalinity	CO_2	pH
Raw Water	500	22	....	7.1
Treated Water Aerated and Filtered	0	10	4.5	6.5

Caustic soda is to be applied to the effluent to produce a pH close to 8. Less than a grain per gallon will usually be required.

Acknowledgement. — The foregoing was presented at the 1929 convention of the New England Water Works Association.

*"Significance of Hydrogen-Ion Concentration in Drinking Water and Particularly for the Business of Water Supply," by A. Massink and J. A. Heymann, translated into English by Frank Hannan. Jour. A. W. W. A., vol. viii, p. 240.

Zeolite Water Softening for Municipal Purposes

General Features of Zeolite Softening Plant, of Combination Treatment Lime Followed by Zeolite, Together with Descriptions of Two Recently Installed Municipal Zeolite Softening Plants

By H. B. CRANE

Principal Assistant Engineer, International Filter Co., Chicago

THE illustration, Fig. 1, is a flow diagram through a pressure type zeolite softening plant. The equipment shown is suitable for handling a clean, clear raw water supply that does not need filtering. In operating, raw water is pumped through the softener directly into the distributing system, and when the capacity of the zeolite has been utilized, the raw water pump is stopped and a solution of common salt brine is applied to restore the softening properties of the zeolite. A standard soap test, made upon the softened water, is the only one that the operator has to make.

The maximum flow rate per unit that can be obtained from equipment like this is in the neighborhood of 600 G.P.M., and that quantity only under what may be termed favorable operating conditions. This limitation as to flow rate exists because of mechanical difficulties encountered in the construction of pressure steel tanks, and the fact that insufficient time for contact between hard water and zeolite is given, if the velocity of flow through the bed is excessive.

As to the construction of steel pressure tanks,—the diameters of these are limited to 10 or 11 feet in all cases where they are to be shipped assembled, because railroad clearances are generally such that larger tanks than these cannot be handled. The cross sectional area of a 10-foot diameter tank is 78.5 sq. ft., and if the total hardness and composition of the hard water is such that a 7-gal. per square foot per minute operating rate is permissible, it would appear that a single unit softener of this type might satisfactorily handle the requirements of a city of 4,000 or 5,000 inhabitants. This is actually not the case, however, because such a wide variation generally exists in any city of this size, between maximum and minimum softened water demands that it would not be economical to operate by direct pumpage. A clear well below the softener would be provided and a high service pump installed to afford greater protection in meeting variable demands and to insure greater operating economy.

It is impossible to supply any figures that may be applied generally in arriving at the probable cost of a zeolite plant. Too many variables must be considered to make this possible. For example, the capacity between regenerations, the permissible operating rate, and salt consumption of the zeolite are based upon the hardness and chemical composition of the water to be treated. Capacity and operating rate are higher for waters of low hardness than they are for waters of high hardness, while salt consumption may vary with the amount of raw water hardness present. A reliable cost estimate for a zeolite plant cannot be made until all the varicities and towns. Different construction materials than those indicated are more economical for plants softening a million gallons or more daily, and in these cases, reinforced concrete supplants wood or steel in tank and reservoir construction. Gravity filter and zeolite beds are used because large volumes of sand and zeolite can be most economically handled that way, while coagulating basins are built practically at ground level to save money in construction and operation.

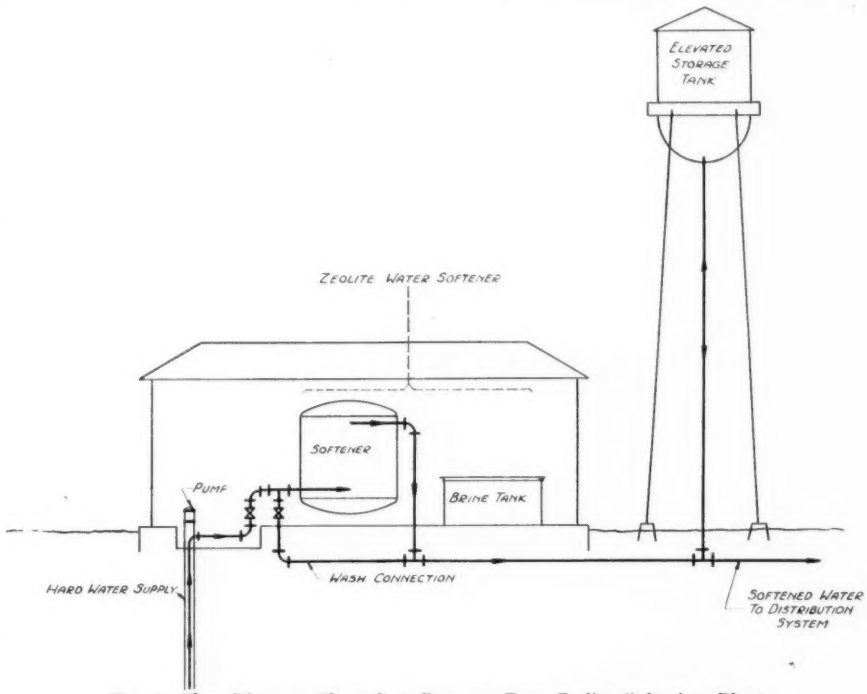


Fig. 1—Flow Diagram Through a Pressure Type Zeolite Softening Plant

able conditions that may affect its size and operation are known.

Lime-Zeolite Softening Plant.—Figure 2 is a flow diagram of a lime-zeolite softening plant in which pressure shells are used as containers for filter sand and zeolite and in which a steel or wood tank may be used for coagulation and sedimentation. Here, the raw water is pumped to the top of the coagulating tank, where sufficient lime is added to remove practically all of the carbonate hardness. After settling, sufficient CO_2 gas is added to stabilize the water and prevent after-precipitation on sand or zeolite beds and in pipe lines. The high service pump then forces the water through the sand filter to clarify it and also through the zeolite bed where all remaining hardness is removed, and thence into the distribution system.

The illustrations thus far have all indicated types of plant construction that are suitable primarily for the smaller

Steps in Treatment in Lime-Zeolite Plant.—Figure 3 is also a flow diagram which shows how the various steps in treatment are carried out in a lime-zeolite softening plant of sufficient size to warrant reinforced concrete construction throughout. From the source of supply, the hard water is pumped to the reaction tanks where sufficient lime is added to remove all the carbonate hardness. It flows from these tanks under the head established there, through the coagulating basins, the filters and into the clear well for lime softened water underneath the filters, being stabilized with CO_2 gas enroute at the point indicated. The first clear well must be large enough to hold sufficient water for operating whatever number of zeolite beds are required, together

with sufficient quantities for backwashing filters, washing and brining zeolite beds plus a reasonable margin to supply demands when one or more filters may be out of service for repairs.

Transfer pumps pick up the lime treated water and force it through the zeolite beds and thence to the second compartment of the clear well which stores the zeolite softened water. The high service pumps of course supply the distribution system. Low head pumps handle the transfer service mentioned above,—not over 25 or 30 ft. head (including suction lift) has to be overcome in the transfer from one clear well to the other, during which the zeolite softening takes place.

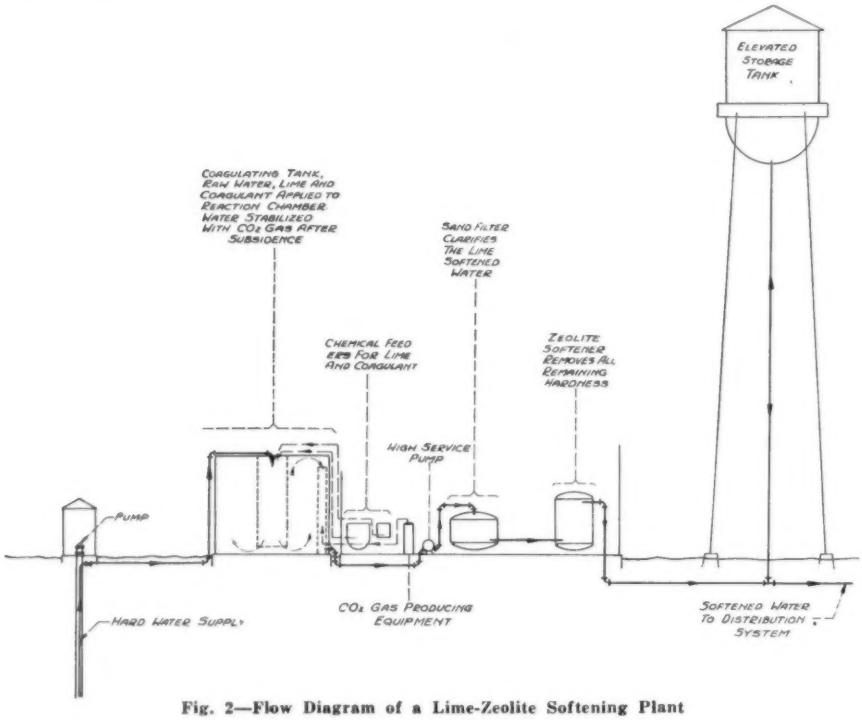

ELEVATED STORAGE TANK
COAGULATING TANK, RAW WATER, LIME AND COAGULANT APPLIED TO REACTION CHAMBER. WATER STABILIZED WITH CO_2 GAS AFTER SUBSIDENCE
SAND FILTER CLARIFIES THE LIME SOFTENED WATER
CHEMICAL FEEDERS FOR LIME AND COAGULANT
ZEOLITE SOFTENER REMOVES ALL REMAINING HARDNESS
HIGH SERVICE PUMP
PUMP
HARD WATER SUPPLY
CO_2 GAS PRODUCING EQUIPMENT
SOFTENED WATER TO DISTRIBUTION SYSTEM

Fig. 2—Flow Diagram of a Lime-Zeolite Softening Plant

Control of Hardness.—Quite a few municipal water softening plants are so operated that the hardness of the finished product is controlled. This is accomplished by mixing in correct proportions, water that has been completely softened with hard water or water that has had only part of its original hardness removed. For example, lime or lime and soda softened water may be mixed with the unsoftened supply; zeolite softened (zero) water with hard; or lime softened water with zeolite softened water in the case of the combined treatment described above. A water of uniform hardness can easily enough be maintained, and no more change in chemical quality occurs than in total hardness. It seems unnecessary, and in some cases it may be even inadvisable to completely soften the city's water supply that is used for all purposes, and an appreciable saving can be made in raising the hardness of the product to 6 or 7 grains. The mixing of waters of different hardness can take place in the clear well and be automatically controlled by proportioning the quantities of softened and hardening waters entering the well.

Brief descriptions will be given of two municipal zeolite softening plants recently installed. These plants are representative of modern practices in construction and operation, and the general features of both are applicable to softening many Kansas supplies.

Zeolite Softening Plant of Springdale, Pa.—Figure 4 is an illustration of the softeners operated by the Borough of Springdale, Pa. The water supply comes from several wells, the average hardness of which is about 20 grains per gallon, the ratio of temporary to permanent hardness content being almost 2 to 1. It is pumped upwardly through the zeolite beds, the softened water is collected at the top and flows from that point to a softened water storage reservoir of considerable size located below the softeners. The zeolite beds are approximately 78 in. in depth and the two steel tanks shown open at the top, are 7 ft. in diameter and 12 ft. high.

Each softener produces 90,000 gal. of zero hardness water per regeneration and the operating rate for each is approximately 230 G.P.M.

The salt consumption under these conditions averages about .325 pounds per 1,000 grains of hardness removed. Salt is purchased in bulk, car lots, and is stored in a wet salt bin or saturator built of reinforced concrete outside the softener building. The saturated solution flows by gravity to a small dosing tank inside the building and is applied to the zeolite during regeneration by an hydraulic ejector which pumps the strong brine out of the dosing tank, dilutes it with the pressure water used and forces the diluted brine through the zeolite bed.

High service pumps, brine dosing tank and a high service venturi meter are all located in a pit in front of the softeners. The building extends over the entire water softening plant and softened water reservoir, is substantially built of brick and presents a very attractive appearance.

Water of no hardness is pumped into the mains at Springdale.

Zeolite Plant Softening Plant of Mangum, Okla.—A zeolite plant of quite different construction and arrangement is operated by the city of Mangum, Okla. The water treated there also comes from wells and averages about 28 grains per gallon total hardness, the quantity of carbonate hardness present being in excess of the non-carbonate.

The plant is designed to supply the city with 1 M.G.D. of water containing 3 grains per gallon of hardness, the hardness being automatically controlled here by bypassing and mixing a portion of hard water with the completely softened water from the zeolite beds.

The zeolite beds, 66 in. deep, are operated in two reinforced concrete gravity basins 11x12 ft. in plan and 10 ft. deep. Fig. 5 is an interior view of the softening plant showing the operating control tables with the two zeolite beds in the background. A salt saturator

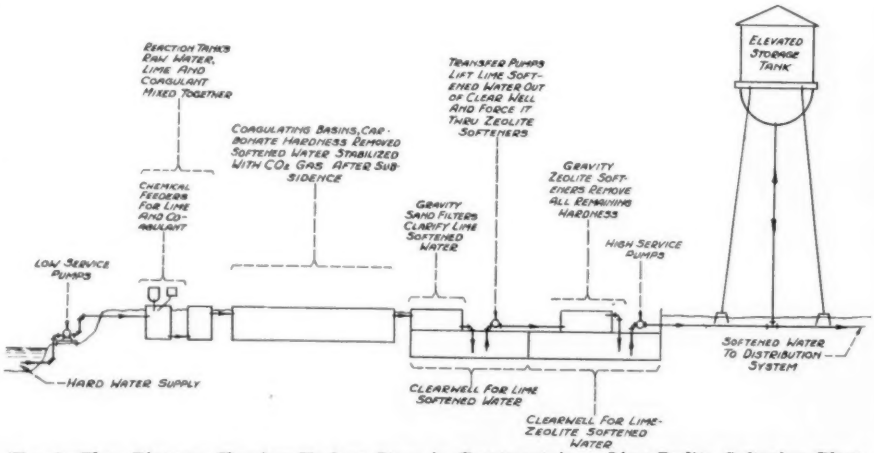

REACTION TANKS RAW WATER, LIME AND COAGULANT MIXED TOGETHER
COAGULATING BASINS, CARBONATE HARDNESS REMOVED SOFTENED WATER STABILIZED WITH CO_2 GAS AFTER SUBSIDENCE
TRANSFER PUMPS LIFT LIME SOFTENED WATER OUT OF CLEAR WELL AND FORCE IT THRU ZEOLITE SOFTENERS
ELEVATED STORAGE TANK
CHEMICAL FEEDERS FOR LIME AND COAGULANT
GRAVITY SAND FILTERS CLARIFY LIME SOFTENED WATER
GRAVITY ZEOLITE SOFTENERS REMOVE ALL REMAINING HARDNESS
HIGH SERVICE PUMPS
LOW SERVICE PUMPS
HARD WATER SUPPLY
SOFTENED WATER TO DISTRIBUTION SYSTEM
CLEARWELL FOR LIME SOFTENED WATER
CLEARWELL FOR LIME-ZEOLITE SOFTENED WATER

Fig. 3—Flow Diagram Showing Various Steps in Treatment in a Lime-Zeolite Softening Plant

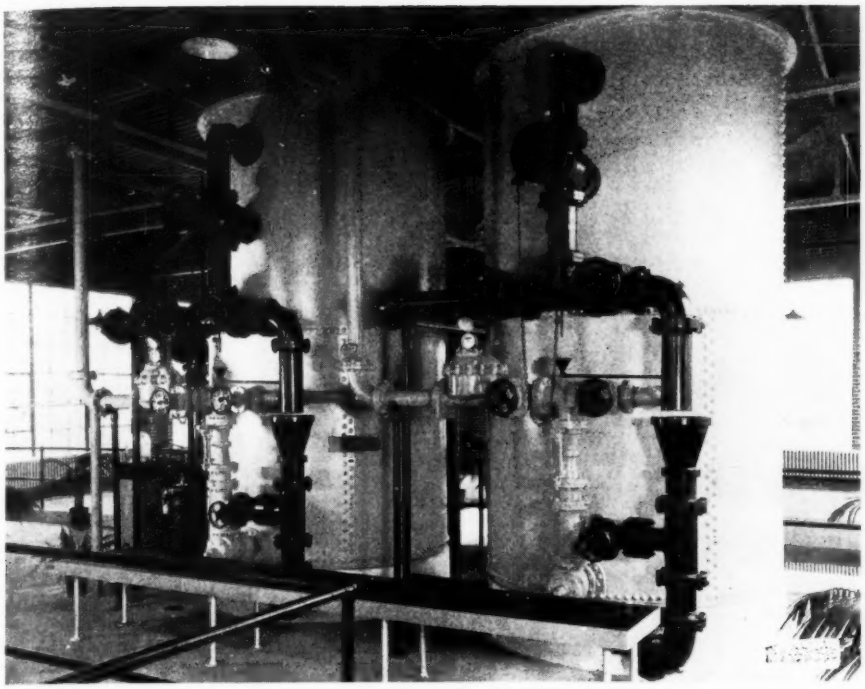


Fig. 4—Softeners Operated by Borough of Springdale, Pa.

and brine measuring sump are located in the building at the left of the picture. Diluted brine is forced through the beds during regeneration by two brine pumps located in the pipe gallery. The average amount of salt used at Mangum is 0.375 lb. per 1,000 grains of hardness removed, a very low salt consumption considering the hardness of the raw water.

This plant is designed and operated much the same as a concrete gravity filter plant. All equipment necessary to secure flexibility and economical operation has been provided.

There is much to be said in favor of softening municipal water supplies with zeolite and if raw water supply conditions are such that this treatment is applicable, its possibilities should be thoroughly investigated. Salt now-a-days is cheap, the softening plant is economical in space requirements, the mechanical equipment is easily taken care of, and operation can be largely a matter of routine.

Acknowledgment.—The foregoing is an abstract of a paper presented Feb. 12 at the fifth annual meeting of the Kansas Waterworks Association.

Starch Coating for Painted Concrete

If a coating of starch is applied to a painted concrete surface, the surface may be cleaned by washing away the coating. Following the washing a fresh coat may be applied.

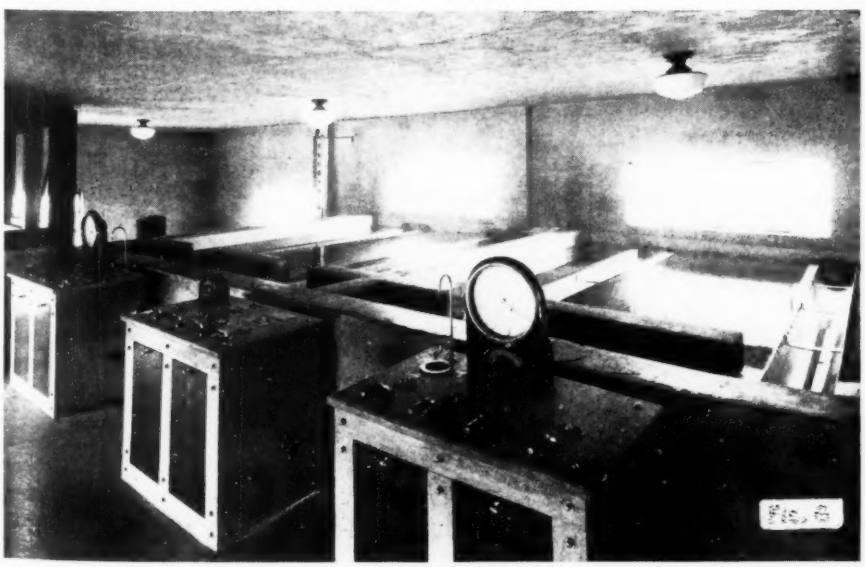


Fig. 5—Interior View of Zeolite Plant at Mangum, Okla., Showing Operating Control Tables with Two Zeolite Beds in Background

Hackensack Water Co. Will Have Central Service Yard

Development of the new Hackensack yard of the Hackensack Water Company, located near the Fairmount Avenue station of the New Jersey & New York Railroad in North Hackensack, N. J. is proceeding rapidly, and by Spring the yard will begin to function as the distribution and service center of the towns supplied by the company.

A railroad siding about 800 ft. long has been installed, and a travelling gantry crane with an overall span of 120 feet has been erected in order speedily and economically to unload and handle pipe and other heavy materials. Pipe will be stored there this winter.

Grading, which involves the excavation and removal of 9,500 cu. yd. of earth, is under way, following the installation of a drainage system. The lower level of the site will be raised from one to three feet, and the upper grade fronting on Hackensack Street will be lowered and straightened by a concrete retaining wall. Building operations will commence as soon as practicable.

The property is 1,000 ft. long and 200 ft. wide with an entrance on Temple Avenue and on Hackensack Avenue. Fronting the lower court will be a large warehouse one story high, and an office building to house the construction division staff.

On the upper level is the rear of the office structure and fronting on a central court will be a motor vehicle repair shop, facilities for employees, and garages for both large and small trucks. The plans provide for extensions to the garages and for a meter repair and testing shop.

The purpose of the yard, according to the President of the Company, Nicholas S. Hill, Jr., is the consolidation of supplies and materials and of transportation and construction control. Operating in connection with the Central Service Bureau of the Company at Weehawken, the new division yard will enable the water supply organization to respond more readily to the needs of the communities served.

The company now maintains pipe yards at Englewood, Hackensack, Carlstadt, New Milford, and Westwood. These are being merged into one mechanically served yard, eliminating the hand loading of pipe at scattered railroad stations.

1930 Convention of Southeastern Section, A. W. W. A.—The 19th annual convention of the Southeastern Section of the American Water Works Association will be held in Savannah, Ga., April 15, 16, and 17. W. H. Chapman, Laurens, S. C., is secretary-treasurer.

Water Works and Sewerage

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Announcing "Motive Power," the Sixth Magazine of the Gillette Group

Twenty-four years ago last month the first of the Gillette Group of magazines was launched, namely "Engineering and Contracting." A sixth member, "Motive Power," now joins this group. In the order of seniority the group consists of:

Engineering and Contracting.
Roads and Streets.
Water Works and Sewerage.
Tiles and Tile Work.
Motor Freight.
Motive Power.

Each of the six is a highly specialized magazine, and, with one exception, each is the circulation leader in its specialized field.

"Motive Power" does not attempt to cover the broad field of prime movers, but only that part of the field in which the power units are portable. Perhaps with equal propriety its name might be Mobile Power. There is no other power magazine in this highly specialized field, but it seemed clear to the publisher that the time is ripe for the introduction of such a magazine.

The problems of the designers and users of large stationary power units have only a general kinship with the problems that exist where small, portable power units are required. To make this strikingly evident take the problem of fuel efficiency in a turbogenerator plant of 50,000 kilowatts running continuously, and contrast it with the fuel problem in a 5 horse-power gasoline motor used intermittently to operate a construction derrick. In the first case the fuel consumption per kilowatt-hour is of paramount importance. In the second case it is of negligible importance. But in the case of the small portable power unit, there looms into prominence its ruggedness and ability to stand up under rough handling and when exposed to every sort of weather. Like the modern motor on an automobile it must be "fool proof," in addition to which it must be "weather proof" and capable of working in a cloud of dust that would stifle a less rugged machine.

In a sense the portable power units that operate construction machinery are mechanical mules, and like their muscular prototypes they must be able to work in dust, rain and mud, without balking on their rough drivers. An experienced contractor knows this fact and always has known it, and that is why it was many years before such a contractor could be induced to use a gasoline engine; for in the early stages of the development of that type of motive power units, they were as unreliable as a Hottentot's promise. The designers of those early gasoline engines were trained mechanical engineers, but their training had been in the designing of large, stationary power units, that were operated by skilled mechanics, and they had yet to learn that there is a great deal of difference between such conditions and those under which a mechanical mule must labor.

The editor recalls that a large public utility company once employed one of the most celebrated consulting power plant engineers to investigate and report on the make of automobile best adapted to their needs. The report was received and several scores of motor cars were purchased according to the recommendation of that engineer. But it soon developed that that make of car was very unsatisfactory. One of the officers of the utility company told the editor that almost the poorest car for their uses was the one that had been recommended by that celebrated power plant engineer. The reason was that although he knew a great deal about large, stationary power units, his knowledge about small, portable units that would be subjected to shocks and rough, careless usage, was really nil. In brief, there are important differences in correctly designing stationary power units and portable power units.

The designer of any machine should be very familiar with the conditions under which it is to be operated. And of course this is equally true of the buyer of the machine. The buyer often knows much more about these conditions than does the designer, so it is very important that the two shall meet to discuss their mutual problems. "Motive Power" expects to furnish a common meeting place for the exchange of facts and ideas. Here also will come the "dealer" in portable equipment operated by power, for he is not only a "middleman" in the sense that he buys to sell again, but in the sense that he conveys information from manufacturer to ultimate buyer and vice versa. He performs an important economic service in exercising both these functions. Also he should be so well informed as to the suitability of each device for any particular kind of service that he can give the best of advice to the ultimate buyer. Finally he should be able to instruct the user of the device as to its most effective handling and maintenance. Let no one think that this sort of "middleman" is an economic burden whose profits should be eliminated by eliminating his services. Quite the contrary. He performs services that can not be dispensed with without economic loss, and since the best of all ways of compensating men is to pay them in proportion to their performance, the profits made by such "middlemen" are not to be begrudged, but rather to be regarded as income earned by satisfactory service.

"Motive Power" will naturally have as its readers the designers and manufacturers of mobile power units, the manufacturers who equip their machines with such units and the dealers who sell those machines to the ultimate users. No special attempt will be made to reach many of the ultimate users with "Motive Power," although the most progressive of them will doubtless

subscribe for this magazine. Other power magazines go mainly to ultimate users of power machinery. They perform an excellent service in showing the power plant superintendent and the "engineman" how to operate machinery with economy. "Motive Power" will not duplicate that service to the ultimate user of power units, but will confine its efforts to aiding the designer and manufacturer of power units and accessory equipment, also the manufacturer who "powers" his portable machines, and the equipment dealer who distributes them to the ultimate user.

Presidents, chief engineers, purchasing agents and other officials of manufacturing companies that use powered equipment and their dealers or distributors will comprise the major part of the subscription list of "Motive Power." To give an idea of the extent of this field of mobile powered equipment the following partial list will serve:

Construction machinery:
- Concrete mixers
- Road rollers
- Road graders
- Excavators
- Derricks and hoists
- Tractors
- Trench pumps
- Air compressors
- Conveyors

Agricultural machinery
Mining machinery
Manufacturing machinery
Logging machinery
Oil field machinery
Earth borers and drillers
Portable saw rigs
Lawn and golf course equipment
Portable electric generators
Welding equipment
Spraying equipment
Fire apparatus
Pumps
Washing machines
Material handling machinery
Motor trucks

The first issue of "Motive Power" furnishes a rather extensive review of the newest developments in mobile power units and the uses to which they are put.

Who Was Semmelweiss?

When the editor was a college student he was taught that no material particles flow through a conductor where an electric current flows, and that it was merely a convenient "scientific fiction" to picture an electric current as a flow of particles. We were told that a wire carrying a strong current is no heavier than when it carries no current; and this was regarded as conclusive proof of the non-materiality of the electric current. Shortly after that time, however, the great English physicist, J. J. Thomson, discovered the electron and determined approximately its mass. Later it was shown that when electrons flow through a conductor they cause electric currents and the concomitant magnetic effects. So, after generations of teaching that Benjamin Franklin was wrong in believing electricity to be a current of material particles, we have come back to belief in Franklin's theory.

Similarly we were taught that heat is not a substance, because hot bodies seemed to be no heavier than cold bodies. The old "phlogiston" theory of heat as a substance was ridiculed by our teachers. Now we know that all energy has mass and gravitates, and that the sun literally sends tons of heat to the earth.

Yet in spite of the radical upset that many physical theories have experienced in recent years, not a little of the old cocksureness still dominates the minds of many scientists. Present to them any radically new theory, and you will become convinced that the typical scientist enjoys nothing quite so well as showing you how wrong you are, unless it be that he enjoys even more the assumption of an attitude of supreme indifference to new theories. It took Einstein almost a generation to secure general recognition of the truth of his relativity theory. It took Agassiz two generations to convince the majority of geologists that his ice-age theory is correct. Fourteen years after Lister had published his discoveries about the antiseptic treatment of wounds, three American surgeons (one an army surgeon) let the editor's brother almost die for lack of such treatment. More than a decade after the efficacy of chlorination of water as a destroyer of typhoid germs was completely proved, thousands of Americans were dying of typhoid every year because doctors either did not know, or, knowing, did not tell the public to chlorinate all city water. And to this day you dare not drink the water that flows from the taps in many a European city. Since the cost of water chlorination is only 2 ct. per capita per annum, the cost does not prevent its use. What does? Ignorance unadulterated and almost universal. Fully three-fourths of the people on this globe do not know how to protect themselves against typhoid. But we need not brag, for the same was true in enlightened America only a few years ago.

Speaking of Lister's great discovery that dilute carbolic acid treatment of wounds destroys septic bacteria, we are reminded of an even earlier discovery of similar nature that Lister had not heard of when he made his epochal discovery. We refer to a discovery made in 1847 by Semmelweiss, Hungarian physician and research genius. He found that by washing their hands with chlorinated lime water, physicians in the lying-in wards of his hospital were soon able to reduce the former mortality ratio of 12 per cent to 3 per cent and later to but slightly more than 1 per cent. Semmelweiss was just an assistant professor in the maternity department in Vienna, and had graduated only three years before he made this great discovery. His superior officer, one Dr. Klein, was so "blinded by jealousy and vanity" that he "drove Semmelweiss from Vienna in 1849." But in the following year Semmelweiss repeated his great achievement in another hospital, where he reduced the mortality well below 1 per cent. He taught other physicians his methods, and in 1861 he published a very full account of it. Lister's antiseptic experiments were not begun till 1864 and his first publication on the subject was in 1867, six years after Semmelweiss had published his first complete account of antiseptic treatment in puerperal cases. It matters little that Lister was a surgeon and Semmelweiss a physician. It does matter, however, that Lister had not heard of Semmelweiss, for that is an

excellent illustration of the ill results of scientific skepticism and professional jealousy. Semmelweiss later was a prophet, but without honor abroad and with scant honor at home. Lister was fortunately and deservedly raised to the British peerage by his discovery of antiseptic treatment, yet even his methods remained unused in many parts of America well into the 80's. Tell us why.

In Kleinn's attitude toward Semmelweiss we see, in extreme form, what probably occurs in mild form far oftener than is supposed, namely an attitude of jealous intolerance. Let any radically new theory be presented before a professional body, and note either the acrimony and sarcasm with which it is usually greeted, or the silence that so often speaks contempt. Note the eagerness and the evident delight with which some apparent defect in a new theory is pointed out. Noting such evidences, be disillusioned if your illusion has been that scientists are of an emotional structure that differs from that of other men.

Ignatz Phillipp Semmelweiss, research genius, died broken hearted and in poverty at the age of 47. Where was Fame dallying that month of May, 1847, when Semmelweiss demonstrated the effectiveness of antiseptic treatment? Holding converse with Jealousy?

"Scientific Caution" Often Born of Ignorance of the Science of Probability

When a new theory knocks at the portals of established science asking admittance, it is commonly met with this question: What authorities vouch for your truth? While this is a reasonable question on the part of a layman, it is wholly unreasonable on the part of scientists who specialize in the field to which the theory relates. They should ask not who is sponsor for the truth of the theory, but what facts indorse it. As a case in point we may quote from Prof. Goldthwait's preface to Antevs' "Recession of the Last Ice Sheet in New England." Speaking of Agassiz's ice-age theory he says: "American geologists for 20 or 30 years hesitated to accept the new explanation (of drift phenomena), owing to the difficulty of conceiving a glacier so thick and so extensive that it could spread its records continuously across uplands and valleys. The unhappy effect of an inhospitable attitude toward a new theory and new methods was clearly illustrated here during the period from 1841 to 1870, when the glacial theory was on probation. Lively discussions of it, as reported in contemporary proceedings of our scientific societies, betray the human tendency to judge a theory by the number and prestige of its adherents and converts instead of by careful and impartial consideration of the evidence."

There is in such cases—and they may be said to be typical—abundant evidence of a combination of professional jealousy and ignorance of research methods that is most discouraging. Since there is little hope of changing human nature save by slow evolution, we will not discuss the professional jealousy feature of the opposition to a new theory. As to removing ignorance of research methods, there is much more hope. In fact, it is certain that this can be accomplished.

To begin with, all scientific men should be taught to read the history of science enough to see for themselves that every theory was not only imperfect at its birth, but has remained imperfect to the present day. Once this fact is fully grasped, it becomes obvious that no theory should ever be rejected because of its defects, provided only that it is in accord with a sufficient body of facts to render its fundamental truth at least possible. Scientists not well enough read to have come to this conclusion are prone to seek for a defect in any new theory, and exultantly hold it aloft as proof conclusive that the theory is false. "False in one, false in all" may be a good maxim by which to judge the reliability of a witness, but it is the poorest of guides in judging the merit of a theory.

Most of us know that an invention is invariably so defective in the early stages of its development that it looks hopeless to all but the inventor himself. Much the same is true of a new scientific theory. Everyone but its discoverer is prone to regard it as fantastic. The discoverer alone sees in it possibilities of development.

Theories always develop. A theory starts as a rather crude explanation, suggested by some analogy between a well known phenomenon that the theory aims to explain. Gradually it becomes evident that while the two phenomena are somewhat alike, they differ enough to make it necessary to modify the embryonic theory. And so, step by step, the theory is modified to bring it into closer and closer accord with the facts. Perfect accord is never attained. Until Einstein appeared on the scene, there was at least one theory, namely, Newton's theory of gravitation, that was regarded as perfect. But behold the recent change of scientific belief!

Jevons was the first scientific writer, we believe, to voice the opinion that no scientific law is perfect. In his "Principles of Science," p. 450, he says: "The further we advance in any generalization, the more numerous and intricate are the exceptional cases still demanding further treatment. The experiments of Boyle, Mariotte, Dalton, Gay-Lussac, and others, upon the physical properties of gases might seem to have exhausted that subject by showing that all gases obey the same laws as regards temperature, pressure and volume. But in reality these laws are only approximately true, and the divergencies have afforded a wide and yet quite unexhausted field for further generalization." On an earlier page (146) he said: "Seldom, indeed, shall we have a theory free from difficulties and apparent inconsistency with facts. . . . Almost every problem in science thus takes the form of a balance of probabilities."

This last sentence gives us another clue to the reluctance of scientists to endorse a new theory. Very few of them seem to know how to weigh a probability. Yet without that sort of knowledge they are incapable of passing safe judgment upon any theory that is susceptible of test by a probability calculation. Undoubtedly "scientific caution" is usually born of a timidity that springs from lack of knowledge of that branch of science known as Probability.

H. P. Gillette

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DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Link-Belt Opens Vancouver Branch Office

Link-Belt, Limited, recently opened a branch office in the Standard Bank Building, 510 West Hastings St., Vancouver, B. C., placing their experienced engineer, Mr. Frank B. Wetherill, in charge.

Mr. Wetherill joined the Link-Belt organization 15 years ago, and for a number of years has been manager of the company's office and warehouse in Portland, Oregon. He is well versed in the application of materials handling and power transmitting machinery to the needs of industry in the Pacific Northwest.

Frank B. Wetherill, Manager, Link-Belt, Ltd., Vancouver, B. C.

In establishing this new office, announcement states that it is the aim to supplement the service which has been rendered through Fleck Bros., Ltd., Canadian Fairbanks-Morse Co., Ltd., and A. R. Williams Machinery Company, Ltd., who, it is stated, will continue as official distributors of Link-Belt chain and other merchandise material.

Mr. Wetherill will not only make use of the large manufacturing works at Toronto and Elmira, Ontario, but will have available the plants, warehouses and engineering facilities of the Pacific Division, Link-Belt Company. The nearest shop and warehouse of this division is located in Seattle, Washington.

The Trend of the Times

Better distribution of materials and supplies is a definite trend of the times and interested manufacturers are eagerly seeking ways to follow this trend, which is a logical step in the simplification program which was fostered by President Hoover while he was Secretary of State.

One result of this movement toward better distribution is the locating of large stocks of standard parts required by industry, in strategic centers throughout the country—a result which benefits both the maker and user. Coupled with the trend toward simplification, it reduces losses formerly incurred by users in paying premiums of time and money for special goods shipped from distant points.

An exponent of this modern distribution efficiency is the Link-Belt Company, Indianapolis, Indiana, known for over 50 years as a manufacturer of power transmission and materials handling equipment. For the past six years their distributors have carried in stock their silent chain drives. They now announce a further extension of power transmission service by arranging with their local distributors for the stocking of Link-Belt roller chain drives (the two wheels and the chain). It is believed that this stepping up of service will add in point of economy and convenience because of the large percentage of power transmission jobs employing these types of drives.

To enable users to take fullest advantage of this service, Link-Belt has further prepared an entirely new data book, giving information and tables from which the user can select the drive needed for his purpose and order from the nearest distributor.

M. D. Tracy Joins Headley Company

Headley Emulsified Products Company, manufacturers of emulsified asphalts, announces the appointment of M. D. Tracy as general sales manager.

Mr. Tracy brings to their organization an excellent merchandising and selling record extending over a number of years as sales manager for The White Company, and later, General Motors Truck Company.

Mr. Edgar S. Ross, president of the company, states that an extensive national sales and distributing organization will be developed as well as South American and foreign trade.

Offices of the company are in the Franklin Trust Building, Philadelphia, with plants at Marcus Hook, Pennsylvania, and Memphis, Tennessee.

Inland Steel Arranges for Acquisition of Coal Mine

Subject only to the investigation of titles and other legal requirements, the Inland Steel Company has purchased from Elk Horn Coal Corporation the latter's Wheelright Mine with its plant and equipment in the Eastern Kentucky coal district, and has leased from the Elk Horn company about 11,000 acres of coal, according to statement of Mr. J. L. Block, vice-president of the Inland Company.

Announcement states that substantial improvements will be made in the plant and equipment to bring production up to approximately one million tons per year. This will give the Inland Steel Company an adequate reserve of high grade by-product coal, it is said.

Clarence W. Hodges

Mr. Clarence W. Hodges, general purchasing agent of the Worthington Pump and Machinery Corporation died at Paterson, New Jersey, on January 17th. Although he was seemingly in the best of health, he was taken suddenly ill and died at the Paterson Hospital as the result of an operation.

Mr. Hodges was born at Randolph, Vermont, May 15, 1876, and was graduated from Williams College with the class of 1900. For some years he was employed by the American Locomotive Company as purchasing agent, and since 1918 he had been employed in the same capacity by the Worthington Corporation.

Funeral services were held at the West Side Presbyterian Church, Ridgewood, New Jersey, on January 19th, and burial was at Randolph, Vermont. Mr. Hodges was a member of the Phi Gamma Delta Fraternity and of the Ridgewood Country Club. He is survived by his widow and four sons.

20 miles of....
...48-inch
will keep
Albany abundantly supplied with water

CAST Q IRON TRADE MARK mains

One of the finest and largest water supply systems in the country is now in course of construction for the city of Albany, New York. Two lakes with a total capacity of more than twelve and one-half billion gallons are being built twenty miles up in the hills. To carry the water from these lakes, the engineers and city officials agreed on the specification of a cast iron conduit 48 inches in diameter and twenty miles long.

This giant water main is estimated to have a load capacity of 45 million gallons per day, or more than twice the needs of the present city. In other words, this main is planned to supply abundant water when Albany has grown to twice its present size—fifty or one hundred years from now.

Cast iron pipe was specified for this Albany job for the same reason that it is being chosen by many other enterprising cities, *its proved durability*. Cast iron has a record behind it which no other underground pressure pipe material can equal. There are cast iron mains in active service today which were laid more than a century ago.

Cast iron pipe marked with the "Q-check" symbol, as shown above, is produced by modern methods in accordance with established technical specifications. This "Q-check" symbol has been adopted as the trade mark of The Cast Iron Pipe Research Association.

For further facts about cast iron pipe write to Thomas F. Wolfe, Research Engineer, Peoples Gas Bldg., Chicago.

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and use of cast iron pipe. Pipe bearing the "Q-check" mark may be obtained from the following: Alabama Pipe Company, Anniston, Ala.; American Cast Iron Pipe Company, Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Avenue, Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Company, Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Pipe and Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York.

CAST IRON PIPE

Peerless Pump Increases Service Facilities

A lease has been taken on the More-Pak Building, located at the corner of Sacramento and H Streets, Fresno, California, in order to give them increased facilities for furnishing service in the northern part of the state.

Floor area in the new building is said to be approximately 25,000 square feet. The building is being remodeled and will contain a fully equipped machine shop and assembling plant to take care of all kinds of pump repair work and service. A complete stock of parts will be on hand and a complete pump can be assembled and installed on twenty-four hours notice.

Sales and service from this branch of the Peerless Company will be in charge of Mr. L. A. Harnish, who for the past four years has served the company in this capacity. He has at his disposal a large staff of men and cars to care for service and make installations of new units.

Shop work will be under the direction of Mr. A. J. Anderson, who for some time was in charge of the San Jose branch. Twelve men are kept busy in the field service department, and it is expected that ten to fifteen first class mechanics and machinists will be employed in the shop.

Mr. E. F. Lewis who has been in the deep well turbine pump business for twenty-six years is the vice-president of the Peerless Pump Company, and Mr. Walter A. Johnson, another pioneer in the deep well pump industry, is the sales manager. Mr. J. R. Gilbert is assistant sales manager, and Mr. O. F. Blabon, who has been associated with the company for several years is chief engineer.

It is stated that many new and improved features are incorporated in the latest models of Peerless Pumps, and several new units have been added. Peerless units range in size from the new Peerless Junior delivering from 25 to 200 gallons per minute, up to those giving from 150 to 9,000 gallons per minute.

The latest Peerless pumps will be on display at the new headquarters in Fresno where the officers will be pleased to greet their friends and show them the "works."

Roots Merges

The P. H. & F. M. Roots Company, original patentees and for seventy years manufacturers of Rotary Positive Blowers, Pumps and Meters has merged with other interests and is now under the control of the Stacey Engineering Company of Columbus, Ohio, according to recent announcement.

The new organization includes the P. H. & F. M. Roots Company and the Connersville Blower Company, both of Connersville, Indiana, the Wilbraham-Green Blower Company of Pottstown, Pennsylvania, and the Stacey Brothers Gas Construction Company of Cincinnati, Ohio.

Heading the list of officers, Colonel Carmi A. Thompson, of Cleveland, was elected president; Corwin Abbott, vice-president and general manager; Fletcher S. Heath of Columbus, Ohio, vice-president; and Erle G. Meeks, secretary and treasurer. Charles T. Gordon will continue as general superintendent. Announcement states that Mr. E. D. Johnston, who for the past forty-five years has been connected with the P. H. & F. M. Roots Company, has resigned as president of the company and has retired from active business.

The new board of directors consists of Colonel Thompson, F. S. Heath and C. A. Ward of Columbus, Ohio, W. B. Stacey of Cincinnati, J. T. Wilkin, Corwin Abbott and Charles T. Gordon of Connersville.

All companies involved in the merger will maintain their separate identities and organizations, and will continue to operate separately until the final plans of the merger can be consummated.

A. M. Byers Co. Increases Sales Facilities

Some time ago the A. M. Byers Company started on a program of expansion on a wide scale to meet the increasing demand for wrought iron pipe, and as a further step in the expansion program announcement has just been made by Mr. L. M. Johnston, executive vice-president, of a reorganization of sales and distributing facilities throughout the country.

The new arrangement calls for realignment of sales territories, involving the promotion of nine members of the Byers organization to division managerships. The following statement has been issued by Mr. Johnston:

"Figures just compiled for the close of the calendar year show a continued and marked growth of demand for the special services rendered by wrought iron, particularly where corrosion and vibration are problems. The increases are especially notable in standard sizes for home and building installations and replacements.

"The program we have undertaken with regard to our sales and distributing organization is designed to improve and speed up service for builders and contractors, as well as for the marine, railroad and oil industries and other special fields."

Mr. Johnston further states that the new ten million dollar plant which the Byers Company is erecting just north of Ambridge, Pennsylvania, is nearing completion, and will be devoted exclusively to the production of wrought iron by the "Byers New Process" developed by Dr. James Aston, consulting metallurgist for the Byers Company and director of the department of mining and metallurgy at Carnegie Institute of Technology.

The nine division headquarters of this company, and their managers are: Boston, A. A. Gatheman; New York G. W. Hamill; Philadelphia, J. C Chaffe; Atlanta, A. D. Sheere; Houston H. B. Weathersby; Pittsburgh, G. E Clifford; Chicago, M. G. Henderson; San Francisco, H. K. Browning; Tulsa F. W. DeLuce. Railroad business remains under the direction of J. H. Ainsworth, director of sales, with headquarters in Pittsburgh.

Industrial Equipment Offers Service in Far West

One of the well equipped distributor organizations in the far west is that of the Industrial Equipment Company, located at 360 E. Morrison St., Portland, Ore.

For manufacturers who wish to maintain an agency and carry stock in Portland, they offer centrally located display and storage space, and stenographic and telephone service. Separate office space is offered to manufacturers' representatives who wish their own offices, and wires, telephone calls and mail coming to them during absence from city are cared for by the Industrial Equipment office force.

The warehouse of this company is located on a spur track, well situated with reference to freight sheds, and the company has facilities for packing and shipping. They are now representing the McCormick-Deering Tractors, The Trackson Company, Bay City Shovels, Inc., Skagit Steel & Iron Works and Willamette-Ersted Company. Mr. Edward S. Marnon is manager.

Announcement

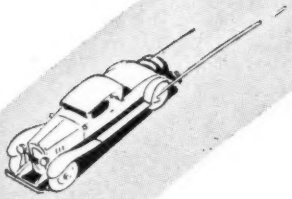
The United States & Foundry Company of Burlington, New Jersey, has issued an announcement concerning deLavaud pipe.

They state that it seems to be the general belief that deLavaud pipe is manufactured only in the thicknesses and weights prescribed in the United States Government specifications.

Announcement states that their company is constantly furnishing this product in strict accordance to the thicknesses and weights of the American Water Works Association and American Gas Association specifications, and they are equipped to manufacture any thickness or weight that may be required.

Chain Belt Company sales for 1929 are announced as just over eight million dollars. This is nine hundred thousand dollars more than in 1928, according to C. F. Messinger, General Sales Manager. It is expected that the Chain Belt Company's earnings for 1929 will be $7.00 per share. For 1928, they were $5.27, and the average for five years is $5.10.

IMPROVE YOUR OLD ROADS



Save Money on Construction and Upkeep

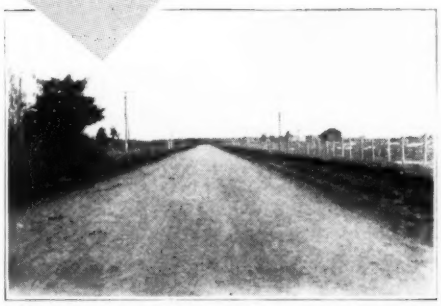
Dirt roads and gravel roads can be made into year 'round, farm-to-market highways with various treatments combining mineral aggregate with asphalt road oil or cut back asphalt.

Such roads are possible with a small appropriation. The present surfacing is not discarded, but is used as a base. The county already has the equipment to do the work. This work requires little labor, as most of it is done by machinery.

These roads are durable. The material is not blown away, but is conserved — it is left on the ground. The road is made better through use.

Thousands of miles of roads in hundreds of counties in the Middle West have been improved with the above treatments, and given complete satisfaction. Because of their low cost, durability and economy of maintenance, such improved roads can be had in your county—this year.

Mail the coupon below for specifications and full information.



Minnesota State Highway. Treatment of subgrade with Standard Asphalt Road Oil. Note smooth, dustless surface which is in good condition throughout the year.

South Dakota Highway. Three inches of gravel being treated with Standard Asphalt Road Oil by the mixed-in-place method. This method insures a durable, year'round riding surface.

Linn County, Iowa, September, 1929. Stanolind Cut Back Asphalt retread just after the keystone has been applied. This method of road improvement is an economical way of salvaging your old road bases.

Four proven road treatments, one of which will fit into your road surfacing program

Preparing Sub-grade with Standard Asphalt Road Oil prior to the application of gravel. When subgrades are treated by this method and covered with 350 cubic yards of gravel per mile, the asphalt road oil does two important things: it holds the gravel in place, and waterproofs the subgrade.

Mixed-on-the-Road Method. An untreated gravel road carrying 500 cars a day loses approximately an inch of surface a year through dust, which is costly waste. You can treat three inches of this gravel by the mixed-in-place method as cheaply as you can maintain the gravel road. When Standard Asphalt Road Oil is specified, the surface obtained will be hard and smooth the year 'round.

Surface Treating of Hard Surfaced Roads, such as compacted gravel, crushed rock and other hard surfaces, with Stanolind Cut Back Asphalt is an economical way of maintaining these roads. It entirely eliminates dust and cutting up in bad weather.

Stanolind Cut Back Asphalt Retread (or mixed-in-place method) is a practical method for building a wearing surface on present road bases. This type of road is easily and quickly constructed. It is non-skid and durable. The cost comes within that of building standard low cost improved roads.

Standard Oil Company
(Indiana) 226

Standard Oil Company *(Indiana)*, Room 1219
910 South Michigan Avenue, Chicago, Illinois
You may send me specifications and plans for improving sec-
ondary roads with Asphalt Road Oil and Cut Back Asphalt.

Name _____

Address _____

City _____ *State* _____

Asphalt and Road Oil for Low Cost Improved Roads

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Distributor thoroughly familiar with bituminous materials and equipment for handling, wishes to add to present lines. Covers Wisconsin and Illinois territory.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Distributor covering New Jersey and New York territory would like to secure a line of street markers or other traffic equipment on exclusive basis.

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for northern California terirtory. Now stocking equipment for several well known machinery manufacturers.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Representatives Wanted

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Manufacturer of paving expansion joints is seeking distributors and manufacturers' agents in good, unassigned territory.

Manufacturer of air compressors and contractors tools has number of desirable territories open. Full co-operation will be extended to distributors.

Manufacturer of patented reflecting signs and devices desires representative for New York City, Long Island, Westchester County and adjacent territory. Some one selling other products to municipalities preferred.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Attractive territory available for experienced men to handle contractors' labor-saving equipment by old established company. Equipment backed by national advertising.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the southwest and middlewest.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

GOLDEN-ANDERSON

Automatic "Cushioned" Controlling Altitude Valves

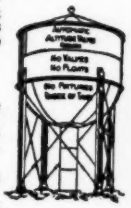
Cushion All Water Surges

Automatically maintains a constant stage of water in reservoirs, tanks and standpipes. They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer. There are no dangerous surges to burst water mains. **Write for details.**



REMEMBER Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

Golden-Anderson Valve Specialty Co.
1385 Fulton Bldg., Pittsburgh, Pa.

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed-water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

GOLDEN-ANDERSON
Patent Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

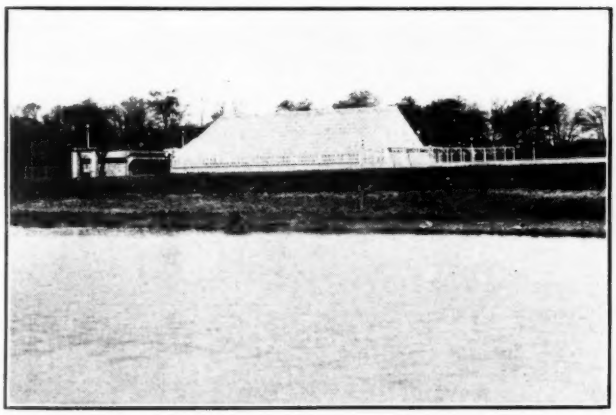
GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves

1. Especially adapted for Water Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering or Sticking.
4. Globe or Angle Patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal-to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.

Sizes ½" to 24".



Modern... Efficient...

KING Sludge Bed Enclosures for Up-to-date Systems

Sanitary engineers the country over strenuously advocate glass enclosure for sludge beds. It offers a number of advantages indispensable to the up-to-date sewage system.

Continuous operation. King Sludge Bed Enclosures make possible all-weather sludge drying. Rain or shine, winter or summer, the sludge beds are ready regularly for sludge removal.

Greater capacity. By equipping the sludge bed with a King Enclosure, its capacity is increased between two and three times. Sludge may be run to a greater depth and dried more quickly.

Elimination of odors. Through control of odors, King Enclosures practically eliminate all offensiveness of sludge beds.

Attractive. King Enclosures are trim and neatly designed, vastly improving the appearance of the disposal plant.

Let us tell you more fully about this modern trend in sewage disposal. Write for descriptive folder on King Sludge Bed Enclosures.

KING CONSTRUCTION COMPANY
533 Wheatfield St., North Tonawanda, N. Y.

Gordon Huth Made Safety Director for Universal Atlas Cement Co.

Rising from a machinist's helper in 1915, when he was 19 years old, to safety director for the largest cement company in the world at 33, is the experience of Gordon Huth of Duluth who on February 10 was appointed safety director for the Universal Atlas Cement Company, a subsidiary of the United States Steel Corporation, according to an announcement by B. F. Affleck, president of that company.

Mr. Huth has been connected with the company for about 15 years, during 11 of which he has been safety inspector at Duluth. In his new position he will have his headquarters in Chicago.

Advance announcement of Mr. Huth's appointment was made on February 5 at the monthly safety meeting of the Industrial Safety Committee of the Duluth Chamber of Commerce of which he was chairman. At that time a message was read from Mr. Affleck congratulating Duluth on the progress it had made in industrial safety and announcing the appointment of Mr. Huth to his new position.

"In three different years," reported Mr. Affleck, "the Duluth plant has won safety trophies for operating a year without a disabling accident. In one of these years it was the only cement plant in the United States to do this. This year it celebrated two years' continuous operation without an accident. The same safety measures in force at Duluth have been followed at our other plants with the result that accidents have decreased 94 per cent in 10 years."

Max Berns Again Heads Advertising Council for C. A. C.

On Jan. 27, the Advertising Council of the Chicago Association of Commerce again elected Max A. Berns as chairman. Mr. Berns is active in the construction field, both in an engineering and advertising capacity, and is publicity manager of the Universal Atlas Cement Company, a subsidiary of the United States Steel Corporation.

The entire field of advertising is covered by the Council, and the officers and directors associated with Mr. Berns are publishers of Chicago daily newspapers, advertising managers of large Chicago manufacturers and retailers, agency executives, direct mail producers, typographers and other groups.

Mr. Berns' work in the engineering and construction field has identified him with movements for winter building, for fire-safe construction, for grade separations and for wider roads and streets. He is a member of the executive committee of the Chicago Association of Commerce and also of the general publicity committee of the association. He has also served as chairman of the contractors and building materials division of the association. He is a member of the advertising committee of the United States Steel Corporation and a director of the Chicago Better Business Bureau.

Max A. Berns, Chairman Advertising Council, Chicago Association of Commerce

For sixteen years Mr. Berns was associated with the Universal Portland Cement Company, with which the Atlas Portland Cement Company recently joined. He is a graduate of the College of Engineering, University of Illinois, and during the World War served as captain of Engineers, U. S. A. He is a member of the Chicago Engineers' Club, Western Society of Engineers, American Society of Civil Engineers, Society of American Military Engineers, Engineering Advertisers' Association, National Industrial Advertisers' Association and International Direct Mail Advertising Association.

Personnel Items from Bay City Shovels

Several personnel changes have been announced by Bay City Shovels, Inc., of Bay City, Michigan, regarding district sales managers for this company.

Mr. C. C. Johnson of Marion, Indiana, formerly connected with the Osgood Company, has been appointed district sales manager for Bay City Shovels in charge of Indiana and Ohio territory.

Mr. C. H. Collier has been appointed district sales manager in charge of sales in the entire state of Texas with offices in the Burt Building, Dallas.

Mr. R. D. Aldrich, formerly of Chicago, will be located at the factory office in Bay City as agency sales manager in charge of all distributors in the central district.

The Eastern Contractors Equipment Company, Frederick, Maryland, will act as exclusive distributors of Bay City for the state of Maryland.

Pomona Pump Company Appoints Argentine Representative

In order to service the Argentine, a distributor for Pomona Pumps has been appointed by The Pomona Pump Company. The David Hogg & Cia. is to represent this company in Buenos Aires.

Don Frederic Klein has been appointed to represent the same company in San Salvador, Central America. By reason of his engineering experience and installations carried out under his supervision, Mr. Klein is said to be well fitted for this new work.

Several Pomona Pumps have been shipped recently to Australia for municipal service near Nhill, Victoria. Bethune Brothers in Nhill are Pomona representatives.

Announcement

The firm of A. E. Moeller Company, manufacturers of hydrometers, barometers, thermometers and similar instruments, has been succeeded by the Moeller Instrument Company.

Announcement states that ownership and management will continue as in the past with the following personnel: Charles E. Moeller, president and general manager; Max E. Moeller, vice-president and head of research department; Curt F. Moeller, treasurer and factory manager; Paul G. Moeller, secretary and director of sales department; Otto J. Moeller, assistant treasurer and glass production department, and Walter G. Moeller, production department.

The Moeller Company is located at 261 Sumpter St., Brooklyn, New York.

Announcement

B. M. Hall, Jr., and Warren E. Hall will continue the consulting practice of B. M. Hall & Sons, civil and mining engineers, Atlanta, Ga. This firm was established in 1899 by Benjamin M. Hall who died November 19, 1929, after more than 50 years of active engineering work.

B. M. Hall, Jr., has been a member of the firm since 1916, while Warren E. Hall served as district engineer U. S. Geological Survey, Water Resources Branch from 1912 to 1924, since which time he has been engaged in private engineering work in North Carolina and Georgia.

Alan Wood Steel Company, Conshohocken, Pa., announces the transfer of Mr. Willard S. Haring from the eastern office to Los Angeles, Calif., as vice-president in charge of western sales.